

**CONSUMPTION OF SUGAR-SWEETENED BEVERAGES AMONG  
CALIFORNIA ADULTS: ROLE OF NEIGHBORHOOD ETHNIC DENSITY,  
ACCULTURATION, AND DISPARITIES**

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## **ABSTRACT**

This dissertation aims to explore whether ethnic disparities exist with sugar-sweetened beverages (SSBs) consumption among adults living in California, and to explore how acculturation and neighborhood ethnic density are associated with SSB consumption. Special attention was given to Asians and their subpopulations in the analyses to assess the disparate risk profiles among these subgroups.

First, we examined 47,397 non-institutionalized adults on the total SSB consumption frequencies and the types of beverages consumed based on the 2009 California Health Interview Survey. Subsequent analyses were conducted among the 5,062 Asian subpopulations. The odds of Asians who consumed any SSB in the past week were similar to Whites (OR: 1.2, 95% CI: 0.9-1.4,  $p < 0.05$ ), while it was significantly higher for African Americans, Hispanics, and Other Races. Significant differences in the frequency and the types of SSB consumed among the Asian subpopulations were observed. The odds of Filipino (OR: 1.9, 95% CI: 1.3, 2.8,  $p < 0.01$ ), Vietnamese (OR: 1.6, 95% CI: 1.0-2.4,  $p < 0.05$ ), and South Asian (OR: 2.0, 95% CI: 1.3-2.9,  $p < 0.01$ ) adults consuming a total of  $\geq 3$  SSB per week were significantly higher compared to Chinese. The predicted marginals also suggest that coffee/tea appears to be the driver of SSB consumption among Asians.

The second study examined the various dimensions of acculturation and how they are associated with SSB consumption frequency among Asian and the Asian subpopulations. Three dimensions, 1) age of arrival in the U.S., 2) language use/media preference, and 3) time exposure to U.S. were identified and used to assess the associations with SSB. Differential associations were observed with the three

dimensions. The U.S. age of arrival dimension resulted in the most number of significant findings in this study. The odds of consuming any SSB were 1.8 (95% CI: 1.2-2.7,  $p<0.01$ ) times higher among all Asians born in the U.S. or have arrived in the U.S. before the age of 18 compared to those who arrived in the U.S. after age 18. These higher odds of total SSB consumption were significant for Chinese- and Japanese-origin Asians: OR=2.8 (95% CI: 1.3-6.0,  $p<0.01$ ) and 2.4 (95% CI: 1.1-4.6,  $p<0.05$ ), respectively.

The third study explored the association between neighborhood ethnic density and SSB consumption among non-Hispanic White, Hispanic, African American, and Asian adults, in addition to a stratified analysis among six Asian sub-populations. Our findings suggest that living in a typical neighborhood where more than 25% of the population comprised of Hispanics is associated with increased soda consumption compared to those who do not live in these neighborhoods, regardless of race/ethnicity (White: OR 1.3, 95% CI: 1.2-1.5,  $p<0.01$ ; Hispanic: OR 1.3, 95% CI: 1.0-1.6,  $p<0.05$ ; Asian: OR 1.5, 95% CI: 1.1-2.0,  $p<0.01$ ; African American: OR 1.8, 95% CI: 1.2-2.7,  $p<0.01$ ). Findings in ethnic Asian neighborhoods were equivocal in which the only significant results were among Hispanic residents who had decreased odds of soda consumption (OR: 0.72, 95% CI: 0.5-1.0,  $p<0.05$ ), but they also had increased odds of flavored/sports drinks (OR: 1.3, 95% CI: 1.1-1.7,  $p<0.05$ ) compared to their Hispanic counterparts.

In conclusion, our results suggest that ethnic differences in SSB consumption exist with Asians having lower odds of SSB consumption occasions compared to Hispanics and African Americans. Differential associations also exist among the Asian subpopulations. Moreover, acculturation and ethnic neighborhoods are associated with increased odds of SSB consumption in some segments of the studied populations.

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## **CHAPTER 1: INTRODUCTION AND SPECIFIC AIMS**

### **1.1 INTRODUCTION**

Recent data on the prevalence of obesity suggest that although its secular trends may be plateauing, two-thirds of U.S. adults remain overweight or obese (Ogden, Carroll, Kit, & Flegal, 2014). Despite a modest decrease in sugar-sweetened beverage (SSB) consumption in the past few years (Welsh, Sharma, Grellinger, & Vos, 2011), a majority of U.S. adults still consume more SSB than is recommended with an age-adjusted mean intake of  $151 \pm 5$  kcal/day (Han & Powell, 2013; Kit, Fakhouri, Park, Nielsen, & Ogden, 2013; Ogden, Kit, Carroll, & Park, 2011; Welsh et al., 2011). There is also strong evidence from systematic reviews to suggest positive associations between the intake of SSB and weight gain among both children and adults (Hu & Malik, 2010; Malik, Schulze, & Hu, 2006; Malik, Pan, Willett, & Hu, 2013; Vartanian, Schwartz, & Brownell, 2007). Based on the most recent meta-analysis on seven prospective cohort studies among adults conducted by Malik et al, each serving of SSB increase per day was correlated with a weight gain of 0.22 kg over one year (95% CI: 0.09, 0.34kg), and in the 5 randomized controlled trials (RCTs), a 0.85kg weight gain (95% CI: 0.50, 1.20kg) was observed when SSB were added (Malik et al., 2013).

Despite extant literature on the consumption of SSB in the U.S., few have included samples from the Asian population in their studies (Kit et al., 2013; Lv & Cason, 2004; Novotny et al., 2009; Novotny, Williams, Vinoya, Oshiro, & Vogt, 2009; Rehm, Matte, Van Wye, Young, & Frieden, 2008; S. Wang, Quan, Kanaya, & Fernandez, 2011), and even fewer, examined these differences among Asian subgroups (Novotny et

al., 2009; S. Wang et al., 2011). The disproportionate effects of obesity, SSB consumption, and other chronic conditions such as diabetes and cardiovascular diseases in minorities including African Americans and Hispanics have been fairly well studied but few have assessed this association among Asians living in the U.S. (Bleich, Wang, Wang, & Gortmaker, 2009; de Koning et al., 2012; Flegal, Carroll, Kit, & Ogden, 2012; Han & Powell, 2013; Hu & Malik, 2010; Kit et al., 2013; Malik et al., 2010; Malik, Popkin, Bray, Despres, & Hu, 2010; Malik et al., 2013; Nielsen & Popkin, 2004; Ogden, Carroll, Kit, & Flegal, 2013; Storey, Forshee, & Anderson, 2006; Y. Wang & Beydoun, 2007). Therefore, the development of this proposal was motivated by the remarkable increase in the consumption of SSB in the U.S., its effect on the obesity epidemic in the U.S. in recent years, and the paucity of existing literature assessing the patterns of dietary intake among Asian Americans, despite Asian Americans being the fastest growing population in the U.S. (Census Bureau, 2012) Moreover, research has demonstrated the disparate profiles of health risks within various Asian subgroups (Anand et al., 2000; Jacob & Cho, 2010) and public health practitioners have advocated to assess these Asian subgroups as distinct populations instead of aggregating them into one race category when conducting research (Jacob & Cho, 2010).

In addition, little is known in what ways, if at all, acculturation is correlated with modifiable health behaviors in the Asian American population. It is difficult to corroborate findings from existing literature in this area (Chen, Juon, & Lee, 2012; Lesser, Gasevic, & Lear, 2014; Liu, Berhane, & Tseng, 2010; Novotny et al., 2009; Venkatesh, Weatherspoon, Kaplowitz, & Song, 2013), and the measurements used to assess acculturation are often inconsistent (Baker, 2011; Bharmal, Hays, & McCarthy,

2013; R. Lee, Eunju, & Liu-Tom, 2006; Schwartz, Unger, Zamboanga, & Szapocznik, 2010). Existing evidence suggests that Asian immigrants have adopted some healthy dietary behavior, such as increased whole grains, fruits and vegetables intake (Lesser et al., 2014; Liu et al., 2010; Lv & Cason, 2004; S. Y. Park, Murphy, Sharma, & Kolonel, 2005), but also some unhealthy ones, such as higher consumptions of fats, carbohydrates, red meats, and overall energy intake among those who are more acculturated (Liu et al., 2010; Lv & Cason, 2004; Maskarinec et al., 2006; Maskarinec et al., 2006; S. Y. Park et al., 2005; Y. Park et al., 2011; Pierce et al., 2007; Rosenmoller, Gasevic, Seidell, & Lear, 2011; Satia et al., 2001).

Lastly, research efforts have demonstrated that racial/ethnic neighborhoods, especially African American neighborhoods, negatively affect dietary quality and health (Jackson, Anderson, Johnson, & Sorlie, 2000; Kramer & Hogue, 2009; Kramer, Cooper, Drews-Botsch, Waller, & Hogue, 2010; Landrine & Corral, 2009; Subramanian, Acevedo-Garcia, & Osypuk, 2005). However, previous results regarding racial/ethnic neighborhood and health for Hispanic American adults are less consistent compared to African Americans and again, research on Asians in this area is limited (Acevedo-Garcia, 2001; Acevedo-Garcia, Lochner, Osypuk, & Subramanian, 2003; Eschbach, Ostir, Patel, Markides, & Goodwin, 2004; Gee, 2002; Kershaw, Albrecht, & Carnethon, 2013; Kramer & Hogue, 2009; M. A. Lee & Ferraro, 2007; Osypuk, Diez Roux, Hadley, & Kandula, 2009; Patel, Eschbach, Rudkin, Peek, & Markides, 2003; Reyes-Ortiz, Ju, Eschbach, Kuo, & Goodwin, 2009). In summary, more research is warranted to gain a better understanding of how individual and neighborhood level factors affect the consumption of SSB among these less studied minority populations.

## **1.2 GOAL**

The overall goal of this dissertation is to examine whether ethnic differences exist in sugar-sweetened beverages (SSB) consumption and to gain a better understanding of the factors that influence such consumption among adults in California. Specifically, this study is interested in examining these differences within the various subgroups of Asian American populations. It also seeks to assess social and environmental factors, including acculturation and neighborhood racial/ethnic concentration, on SSB consumption among minority adults in California. Three research questions were examined. The first paper explored the ethnic differences and individual factors that may contribute to increased SSB consumption. The second paper examined various dimensions of acculturation and their associations with SSB consumption among Asian American adults. The third paper assessed whether living in neighborhoods with a high concentration of minority populations is related to increased SSB consumption.

### **1.2.1 Specific aims and hypotheses**

**Aim 1:** To examine whether ethnic differences exist in the consumption of SSB and to explore other individual level factors that are associated with SSB consumption among adults in California

**Hypothesis 1a:** the consumption frequency of SSB among Asians would be lower than their Hispanic and African American counterparts; and

**Hypothesis 1b:** the patterns of SSB consumption would be significantly different among the various Asian subpopulations, with Filipino, South Asian, and

Japanese adults consuming more SSB than other Asian counterparts (Chinese, Korean, and Vietnamese adults)

**Aim 2:** To examine different dimensions of acculturation and their differential associations with SSB consumption among Asian American adults in California.

**Hypothesis 2a:** increased level of acculturation, regardless of the acculturation dimension measured, would be associated with an increased frequency of SSB consumption; and

**Hypothesis 2b:** differential levels of association with SSB consumption would be observed with various dimensions of acculturation.

**Aim 3:** To examine the association of neighborhoods with different ethnic densities and SSB consumption

**Hypothesis 3a:** different ethnic profiles/densities of neighborhoods are associated with different SSB consumption patterns.

**Hypothesis 3b:** the predominant ethnic group in a neighborhood can modulate the SSB consumption pattern of the other groups in that neighborhood.

**Chapter 2** of this dissertation provides an overview of the background on the three dissertation objectives, a literature review of previous studies related to the objectives, a description of the 2009 California Health Interview Survey, and research methods. **Chapters 3, 4, and 5** are the three individual papers for the above three specific aims. Each paper includes its own introduction, methods, results, discussion, and conclusion sections. **Chapter 6** summarizes the findings from these three studies and

provides a general discussion, policy implications, and conclusion of the entire dissertation.

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## **CHAPTER 2: BACKGROUND, CONCEPTUAL FRAMEWORK, AND RESEARCH METHODS**

### **2.1. BACKGROUND**

#### **2.1.1 Liquid Calories, Energy Compensation, and Dietary Quality**

The differential effects of solid and liquid forms of carbohydrate on satiety, energy compensation, and total energy intake have been an area of research in recent years. Satiety is defined as the effects of food, regardless of physical forms (i.e. solid or liquid), after one's eating period has ended. Energy compensation, or caloric compensation, refers to the ability to respond to changes in caloric content or intake, such as the adjustment to reduce energy intakes on some occasions as an effort to compensate for increased consumption on other occasions (Rolls, 2009). Both of these factors have an effect on the total energy intake an individual consumes on a short term and long term basis. When an individual is unable to maintain one's energy balance over time, it then results in weight gain and individuals are then at risk of overweight or obesity.

A number of studies suggest that energy consumed in liquid form may induce less satiety and that energy compensation may be less effective when compared to the same energy consumed in solid form (Akhavan & Anderson, 2007; Drewnowski & Bellisle, 2007; Leidy, Apolzan, Mattes, & Campbell, 2010; R. Mattes, 2006; Moran, 2009; Pan & Hu, 2011; Stull, Apolzan, Thalacker-Mercer, Igley, & Campbell, 2008; Tieken et al., 2007). A recent review of literature by Pan and Hu suggests that liquid carbohydrates induce less satiety compared to solid form in adults (Pan & Hu, 2011). In the study conducted by Akhavan et al, it demonstrated that the treatment group who received gelatin (solid form) of sucrose compared the group that received it in liquid form had a reduction in appetite (Akhavan & Anderson, 2007). A randomized cross-over study

comparing the effects of additional liquid (soda) and solid (jelly beans) loads during *ad libitum* diet demonstrated an overall increase in energy intake and weight during the liquid load period but not during the solid load period (DiMeglio & Mattes, 2000). Daily non-supplement energy intake was adjusted downward (compensated) after consuming solid loads but not after consuming liquid loads, suggesting that increased consumption of carbohydrate liquids may be associated with positive energy balance (DiMeglio & Mattes, 2000).

A few studies have specifically demonstrated that SSBs have minimal impact on increasing satiety and contributing to additional caloric intake to a meal (Almiron-Roig & Drewnowski, 2003; DiMeglio & Mattes, 2000; Drewnowski & Bellisle, 2007; Flood, Roe, & Rolls, 2006; R. Mattes, 2006; Reid, Hammersley, Hill, & Skidmore, 2007; St-Onge et al., 2004; Vartanian, Schwartz, & Brownell, 2007). One study which examined the effects of isocaloric sugar-only beverages versus beverages containing mixed-nutrient demonstrated that subjects (N=20) reported greater feelings of satiety ( $p<0.05$ ) with the mixed-nutrient beverage compared to the sugar-only beverage (St-Onge et al., 2004). Flood et al studied the effect of the size (12 or 18 fl oz) and beverage type (cola, diet cola, or water) on the overall energy intake at an *ad libitum* meal and found that energy taken from food did not alter based on the type or the size of the beverage (Flood et al., 2006). Moreover, in a meta-analysis of 5 longitudinal and 12 cross-sectional studies assessing the relationship between soft drink consumption and energy intake, all 5 longitudinal and 10 of the 12 cross-sectional studies demonstrated positive associations (Vartanian et al., 2007).

Several studies have investigated the associations between SSB and various dietary behaviors and found that increased SSB consumption is associated with poorer diet quality among adults (Huth, Fulgoni, Keast, Park, & Auestad, 2013; Odegaard et al., 2012; Odegaard, Choh, Czerwinski, Towne, & Demerath, 2012; Qi et al., 2012; Vartanian et al., 2007). Evidence from these studies suggests an association between increased SSB consumption and poorer diet quality in adults, such as the displacement of nutrient-dense foods, lower intakes of macronutrients and fiber, and greater estimated energy and carbohydrate intake with increased SSB consumption (Odegaard et al., 2012; Vartanian et al., 2007). Another study demonstrated that individuals with higher SSB consumption had higher total energy intake and lower scores on the Alternative Healthy Eating Index, an index that measures diet quality (Qi et al., 2012). Furthermore, the assessment of the 2003-2006 National Health and Nutrition Examination Survey (NHANES) data on the U.S. diet and its contribution to essential nutrient intake suggests that a reduction in SSB consumption could reduce the total caloric intake in the U.S. population without compromising the overall nutritional quality of the diet (Huth et al., 2013).

### **2.1.2 Obesity and Sweetened Sugar Beverages**

Obesity is a major public health problem in the United States and other industrialized countries, and is a rapidly growing threat to the health of populations in many developing nations (WHO, 2000). The proportion of overweight and obese populations in the U.S. has risen markedly in the past few decades. Between 1980 and 2008, obesity prevalence doubled in adults aged 20 years or older, although the rate of increase in prevalence seems to be at a lower rate from 1999 to 2009 compared years



prior (Flegal, Carroll, Ogden, & Curtin, 2010; Flegal, Carroll, Kit, & Ogden, 2012). Most recent studies show that two-thirds of the adult population in the U.S is either overweight or obese (Flegal et al., 2010; Flegal et al., 2012; Ogden, Carroll, Kit, & Flegal, 2013; Ogden, Carroll, Kit, & Flegal, 2014; Y. Wang & Beydoun, 2007). Evidence from national surveys conducted in the U.S. suggests that the self-reported amount of foods and beverages, total energy intake, and the amount of foods and calories per eating episode have experienced an increase in secular trend between 1977 to 2002 (Kant & Graubard, 2006). At the same time, the consumption of added sugars and sugar-sweetened beverages (SSB) in the U.S. has increased dramatically, and its temporal patterns are parallel to the rise in obesity (Bleich, Wang, Wang, & Gortmaker, 2009; Han & Powell, 2013; Malik, Popkin, Bray, Despres, & Hu, 2010; Qi et al., 2012).

While recent data suggest that the increases in the population prevalence of obesity previously observed may not be continuing at a similar rate, there is no indication that the prevalence of obesity is declining in the U.S. (Flegal et al., 2012; Ogden et al., 2013). Furthermore, SSBs continue to be the leading source of calories and added sugar in both adults and children in the U.S. (Hu & Malik, 2010; Huth et al., 2013; Welsh, Sharma, Grellinger, & Vos, 2011). Sugar-sweetened beverages, therefore, have been an area of increased interest to both researchers and policymakers in recent years as an increasing number of studies are confirming the positive associations of SSB consumption with increased body weight and the risk of overweight/obesity (Gibson, 2008; Hu & Malik, 2010; Malik, Schulze, & Hu, 2006; Malik, Pan, Willett, & Hu, 2013; R. D. Mattes, Shikany, Kaiser, & Allison, 2011; Te Morenga, Mallard, & Mann, 2012).

Sugar-sweetened beverages include a wide spectrum of beverages that are often sweetened by high fructose corn syrup, including soda, fruit drinks, energy and sports drinks, and vitamin water drinks. The *2010 Dietary Guidelines for Americans* define SSBs as “liquids that are sweetened with various forms of sugar that add calories. These beverages include, but are not limited to soda, fruitades and fruit drinks, and sports and energy drinks” (DHHS, 2010a). A series of meta-analyses on the association of SSB and weight gain among children and adults were published recently to determine the role of SSB in the current global obesity epidemic, and most studies have found that the intake of SSB was positively associated with weight gain or risk of overweight and obesity (Hu & Malik, 2010; Malik et al., 2006; Malik, Popkin, Bray, Despres, & Hu, 2010; Malik et al., 2013; R. D. Mattes et al., 2011; Vartanian et al., 2007). A meta-analysis conducted in 2011 that included six randomized controlled trials (RCTs) found a positive dose-response increase in weight when SSBs were added to the diet (R. D. Mattes et al., 2011). More recently, a systematic review and meta-analysis conducted in 2013 on 22 prospective cohort studies (7 of which were adults) and 10 RCTs (5 of which were adults) assessing the relationship between SSB and body weight concluded an overall positive relationship between SSB consumption and body weight gain in both populations (Malik et al., 2013). Among the cohort studies, this meta-analysis demonstrated a 0.22kg (95% CI: 0.09-0.34kg) and 0.12 kg (95% CI: 0.10, 0.14kg) of weight gain in adults with each incremental increase in the daily serving of SSB over a one-year period in the random and fixed effects model, respectively (Malik et al., 2013). Moreover, three separate cohorts involving 120, 977 U.S. adults that were evaluated over 4-year intervals have demonstrated the effect of SSB on long term weight gain

(Mozaffarian, Hao, Rimm, Willett, & Hu, 2011). Within each of the 4-year interval cohort, an average of 1.00lb ( $p<0.005$ ) was gained with an incremental increase in daily serving of SSB (Mozaffarian et al., 2011).

Scientific studies on the association between SSB reduction and weight loss is not as great in quantity compared to those investigating weight gain, but a number of studies conducted in recent years are providing increasing evidence to suggest that a reduction in SSB consumption is associated with weight loss. The World Health Organization had commissioned and published a meta-analysis of RCTs that found a positive association between reduced intake of dietary sugars and weight loss of 0.80kg (95% CI: 0.39-1.19) among adults with *ad libitum* diets (Te Morenga et al., 2012). In the PREMIER trial, Chen et al demonstrated that a reduction in liquid calorie intake of 100kcal per day was associated with a weight loss of 0.25 kg (95% CI: 0.11-0.39) and 0.24kg (95% CI: 0.06-0.41) at 6 and 18 months, respectively, among U.S. adults (Chen et al., 2009). Barone-Gibbs et al also demonstrated that that weight loss among US adult women was independently associated with decreased SSB consumption at 6 and 48 months (Barone Gibbs, Kinzel, Pettee Gabriel, Chang, & Kuller, 2012). However, despite increasing evidence pointing towards this positive correlation, one meta-analysis conducted in 2011 included six randomized controlled trials (RCTs) did not find a significant association between decreased SSB consumption and a decrease in body mass index (BMI)(R. D. Mattes et al., 2011). Therefore, these inconsistencies in findings would still require further investigation in determining whether a reduction in SSB consumption truly has a positive effect on weight loss and in reducing the prevalence of overweight and obesity.

### **2.1.3 Sweetened Beverage Consumption and Trends in the U.S.**

As stated, the consumption of added sugars and SSBs in the US parallels the rise in the prevalence of overweight and obesity in the U.S. (Bleich et al., 2009; Duffey & Popkin, 2007; Flegal, Carroll, Ogden, & Johnson, 2002; Han & Powell, 2013; Malik, Popkin, Bray, Despres, & Hu, 2010; Qi et al., 2012). Between 1977 and 2001, the percent of calories from all beverages in the U.S. increased by more than 50% while the prevalence of obesity among US adults doubled (Duffey & Popkin, 2007; Flegal et al., 2002). Data from national surveys demonstrate a secular increase in beverage consumption from the 1960s to early 2000s in the U.S, with an increase caloric count from 236 kcal/day to 458 kcal/day between 1965 and 2002 (Bleich et al., 2009; Duffey & Popkin, 2007; Nielsen & Popkin, 2004). In addition, the proportion of daily caloric intake from beverages also increased over this period. Beverages accounted for roughly 12% of total calories in 1965 and by 2002, they accounted for 21% of the total daily caloric intake in the U.S. In 1965, only 17% of the general population consumed more than 25% of their daily caloric intake from beverages, but the percent increased to 30% in 2002 (Duffey & Popkin, 2007).

National data, from the early 2000s and onward, however, suggest a moderate temporal decrease in added sugar and SSB consumption in the U.S, along with a decrease in total energy intake during the same period (Han & Powell, 2013; Kit, Fakhouri, Park, Nielsen, & Ogden, 2013; Ogden, Kit, Carroll, & Park, 2011; Welsh et al., 2011). Using NHANES data from 2000-2008, Welsh et al found that the total percent of daily caloric intake from sugar beverages among the US population decreased from 9.3% ( $\pm 0.5$ ) to 6.6% ( $\pm 0.4$ ) in 2000 and 2009, respectively. The total energy intake during this same

period also decreased from 2145 kcal/day (2008, 2192 kcal/d) to 2069 kcal/day (2018, 2121 kcal/d) in this study. The mean grams of sugar consumed per day from soda and fruitades/sports drinks also decreased from 37.4 ( $\pm 2.2$ ) and 10.7 ( $\pm 0.5$ ) in 2000 to 22.8 ( $\pm 2.1$ ) and 7.4 ( $\pm 0.4$ ) in 2008, respectively (Welsh et al., 2011). Another study that extended the analysis to include the 2010 NHANES data drew similar conclusions in the temporal pattern, showing a decrease in SSB consumption in the U.S. and found that adults aged 20 or greater consumed an age-adjusted mean of  $151 \pm 5$  kcal/day from SSBs. This was a decrease from  $196 \pm 10$  kcal/day in 2000 (p trend  $< 0.0001$ ). There was also a decrease in the proportion of adults reporting  $\geq 2$  SSB on a given day and an increase in the proportion of adults reporting no SSB consumption in this study (Kit et al., 2013).

Despite the moderate secular trend decrease in SSB consumption in recent years, SSBs are still a significant component of the American diet. The American Heart Association (AHA) recommends a weekly consumption of  $\leq 450$  kcal of SSB (or no more than 3 cans of 12 fl oz carbonated drinks) (Lloyd-Jones et al., 2010). However, data from 2005-2008 NHANES found that on a given day, 50% of the U.S. population consumes SSB at least once, 25% of the population consumes at least 200 calories from SSB, and 5% was found to consume at least 567 calories from SSB, all of which are still much higher than the AHA recommendation (Ogden et al., 2011).

Furthermore, the patterns in the types of beverage consumed over the last decade seemed to have shifted (Han & Powell, 2013). The recent decline in the overall SSB consumption was mostly attributed to the decrease in regular soda consumption (**Figure 2.1**). However, soda still continues to be the largest contributor of added sugars in the U.S., constituting 37.4% of total added sugar intake in 2000 and 22.8% in 2008 (Huth et

al., 2013; Kit et al., 2013; Welsh et al., 2011). Evidence from the 2000-2008 NHANES data suggests that other SSBs such as sports/energy drinks consumption are on the increase among young adults and adults ( $p < 0.05$ ) (Han & Powell, 2013). The average daily sales of sports and energy drinks in the U.S. increased from an average per capita volume of 3.8 mL in 2000 to 41.1 mL in 2010 (Kleiman, Ng, & Popkin, 2012). Kit et al also found a significant increase in sports and energy drinks consumption ( $p$  trend  $< 0.001$ ) from 2000-2010 and in sweetened coffee and teas ( $p$ -trend  $< 0.05$ ,  $< 0.001$ , respectively) over the same period (Kit et al., 2013).

#### **2.1.4 Types of added sugar in sweetened beverages and their adverse health outcomes**

The majority of foods and beverages had traditionally been sweetened with sucrose (table sugar) in the U.S. until a few decades ago. However, the production of high-fructose corn syrup (HFCS) was developed in the 1970s and since then, HFCS has largely replaced sucrose as the major source of sweetener in SSB in the U.S. since it is cheaper to produce and it is considered more functional due to its stable structure, especially in acidic foods and beverages (Bray, G.A. 2004; 282 Fields, S. 2004). HFCS is similar in composition to sucrose and is comprised of fructose and glucose. While the fructose content of HFCS can be as high as 90%, it is most commonly produced in two forms: HFCS-42 (42% fructose) and HFCS-55 (55% fructose) (Coulston, A.M. 2002). HFCS-55 is the more prevalent form of sweetener in SSB in the U.S. and constitutes approximately 40% of sugar added to foods consumed in the country (Fields, S. 2004). Since the late 1970s, the average daily intake of added fructose and total fructose has increased in the U.S. while the intake of natural fructose (i.e. from fruits, honey) has

remained stable (Marriott,B.P. 2009) . The U.S. is the major user of HFCS globally, and the HFCS percentage of sweeteners increased from 16% to 42% between 1978 and 1998 (Vuilleumier,S. 1993; Marriott,B.P. 2009).

In regards to its biochemical structure, fructose is more lipogenic than other carbohydrates and its metabolism differs from that of glucose. Liver is the main site of fructose metabolism, and upon ingestion, it is rapidly taken up by the liver and fructose enters glycolysis via fructose-1-phosphate, which bypasses the phosphofructokinase pathway, an important rate-limiting step of glucose metabolism. In addition, the ingestion of fructose does not stimulate the production of insulin and leptin, two important regulating hormones in long-term energy homeostasis (Ferder,L. 2010). As a result, the chronic consumption of diets high in fructose is associated with the decreases in insulin responses to meals as well as leptin production. It is hypothesized that this in turn can potentially have long-term adverse health effect in regards to body adiposity and weight gain (Brown,C.M. 2008; Stanhope,K.L. 2009; Elliott,S.S. 2002; Havel,P.J. 2005).

The effects of fructose and health outcomes in humans remain somewhat inconsistent. There is evidence that excessive fructose consumption is positively associated with obesity, metabolic syndrome, and other cardiovascular diseases (Dhingra,R. 2007; Elliott,S.S. 2002; Gross,L.S. 2004; Johnson,R.K. 2009; Teff,K.L. 2009; Hosseini-Esfahani,F. 2011; Moreno,J.A. 2013) , while other studies did not support this positive association (Madero,M. 2011; Melanson,K.J. 2007; Sun,S.Z. 2011). Different forms of fructose including fructose bonded with glucose (i.e. sucrose), natural fructose, and fructose alone have demonstrated various associations (Gaby,A.R. 2005).

Published studies found that high consumption of fructose is negatively associated with insulin sensitivity and increases visceral adiposity among overweight adults (Stanhope, K.L. 2009). Furthermore, it is associated with dyslipidemia among healthy adults with and without a family history of Type 2 diabetes (300 Le, K.A. 2009). Findings from the Framingham Heart study also demonstrated that middle-aged adults consuming one or more SSB daily in the U.S. had increased risks of metabolic syndrome (OR 1.48, 95% CI [1.30-1.69], obesity (OR 1.31, 95% CI [1.02-1.68]), increased waist circumference (OR 1.44; 95% CI [1.09-1.56], hypertriglyceridemia (OR 1.25, 95% CI [1.04-1.51]), and lower high-density lipoprotein cholesterol (OR 1.32, 95% CI [1.06-1.64]) compared to those consuming less than one SSB per day (Dhingra, R. 2007). A recent meta-analysis conducted by Kelishadi et al found a significantly positive association of fructose consumption with increases in fasting blood sugar (0.31; 95% CI: 0.15-0.47;  $p=0.002$ ), systolic blood pressure (0.30; 95% CI 0.14-0.45;  $p=0.002$ ), and triglycerides (0.28; 95% CI: 0.014-0.41;  $p=0.002$ ). At the same time, an inverse relationship with high-density lipoprotein (HDL) cholesterol (-0.27; 95% CI: -0.41 to -0.13;  $p=0.001$ ) was found with increased fructose consumption among adults (Kelishadi, R. 2014).

However, one should be cognizant that in most daily diet, naturally occurring free fructose (i.e. fruits and honey) constitutes a relatively modest percentage of energy intake. The majority of fructose in one's diet comes from added sugar in the forms of either sucrose (50% fructose) and HFCS (usually 42-55% fructose), and not as a standalone component (Tappy, L. 2010). A meta-analysis assessing the effects of free (unbounded, monosaccharide) fructose on human subjects demonstrated that an increase



in weight gain were based mostly on hypercaloric trials, and there seems to be no significant effect in isocaloric trials (Sievenpiper, J.L. 2012). Another meta-analysis had similar findings when assessing the effect of fructose on postprandial triglycerides, in which no significant effect in the isocaloric trials was found and an increase in postprandial triglyceride was only associated with hypercaloric trials (David Wang, D. 2014). Furthermore, a number of the observed changes such as hepatic steatosis and insulin resistance described in the literature were a result of fructose intake that was administered in amounts that largely exceeded habitual daily intake and were under hypercaloric conditions (Tappy, L. 2010). Further research in human subjects is needed to better ascertain the adverse effects of fructose and other nutrients and the metabolic effects of fructose in a weight-maintenance diet.

As mentioned, sucrose was the most widely used added sugar in sweetened beverage in the U.S. before the 1970s. It is a disaccharide that consists of one molecule of glucose and fructose. Most researchers agree that the metabolism and absorption of free fructose (when consumed alone) is different from fructose contained in sucrose (Kelishadi, R. 2014). Although there is no direct evidence that high consumption of sucrose affects the development of diabetes (Laville, M. 2009), it has been documented that diets with high sucrose are positively associated with weight gain (Raben, A. 2002).

### *Artificial Sweeteners*

The consumption of artificial sweeteners has increased dramatically over the past few decades, and approximately 15% of the U.S. population are estimated to consume non-nutritive sweeteners (Mattes, R.D. 2009). A large variety of artificial sweeteners are

NOW available, and they are known to be at least 30 to 13,000 times sweeter when compared with natural sugar (Shankar,P. 2013). Evidence has been inconsistent regarding the effects of artificial sweeteners on energy balance and weight gain. A review conducted by Mattes et al suggests that “if nonnutritive sweeteners are used as substitutes for higher energy yielding sweeteners, they have the potential to aid in weight management, but whether they will be used in this way is uncertain” (Mattes,R.D. 2009). Another systematic review on the effect of sweeteners and health outcomes concluded that there is little evidence to support that nonnutritive sweeteners have positive health benefits, and only two studies were found that incorporating non-caloric sweeteners in one’s diet resulted in the reduction of energy intake when compared to the sucrose groups (Wiebe,N. 2011).

#### **2.1.5 Ethnic Disparities in SSB consumption**

Disparities is defined by the Agency for Healthcare Research and Quality (AHRQ) as “the difference or gaps experienced by one population compared with another population” (AHRQ 2009). Health disparities between populations, especially between black/white disparities and to a lesser extent Hispanic/white disparities, have been fairly well documented. However, there still remains striking disparities in the burden of disease among racial and ethnic minorities in the U.S. The goal of *Healthy People 2010* and *Healthy People 2020* “to eliminate health disparities that occur by race and ethnicity, gender, education, income, geographic location, disability status, or sexual orientation” stems from the national recognition of the need to address this pressing public health issue (DHHS, 2010b).

The disproportionate effects of obesity, SSB consumption, and other chronic conditions such as diabetes and cardiovascular diseases on minorities including African Americans and Hispanics have been fairly well -studied (Bleich et al., 2009; de Koning et al., 2012; Flegal et al., 2012; Han & Powell, 2013; Hu & Malik, 2010; Kit et al., 2013; Malik et al., 2010; Malik, Popkin, Bray, Despres, & Hu, 2010; Malik et al., 2013; Nielsen & Popkin, 2004; Ogden et al., 2013; Storey, Forshee, & Anderson, 2006; Y. Wang & Beydoun, 2007). SSB consumption is particularly high among Hispanics, African-Americans, and individuals in lower socioeconomic status, the same groups that are also disproportionately affected by the high prevalence of overweight, obesity and obesity-related chronic conditions in the U.S. (Bleich et al., 2009; de Koning et al., 2012; Han & Powell, 2013; Hu & Malik, 2010; Kit et al., 2013; Kit et al., 2013; Malik, Popkin, Bray, Despres, & Hu, 2010; Nielsen & Popkin, 2004; Ogden et al., 2011; Storey et al., 2006). Evidence on the higher consumption of SSB among African American and Hispanic adults compared to their non-Hispanic white counterparts is consistent throughout the past two decades, despite the overall decrease of SSB consumption in the U.S. Data from 1999-2002 found that African Americans adults, and to a lesser extent, Mexican American adults had significantly higher average fruit drinks/ades consumption compared to Whites. The amount of fruit drinks/ades consumption for a typical African-American man aged 20-39 was three times more than white men, while it was two times higher among African-American women in the same age group (Storey et al., 2006). Bleich et al demonstrated that 73 ( $\pm 2$ )% and 76 ( $\pm 1$ )% African-Americans adults reported  $\geq 1$  consumption occasion of SSB on the surveyed day, while the percentages were 69 ( $\pm 2$ ) % and 70 ( $\pm 2$ ) % among Mexican Americans, compared to the lower percentages of

56 ( $\pm 1$ ) % and 60 ( $\pm 1$ ) % among whites between 1988-1994 and 1999-2004, respectively. This study also found that young African Americans (aged 20-44) had the highest per capita consumption of SSB compared with White and Mexican American adults (Bleich et al., 2009).

More recent data demonstrated that African American and Mexican American adults aged 20 or older consumed significantly higher SSB kilocalories as a percentage of their total caloric intake. The mean percentage of total daily kilocalories from SSB for non-Hispanic White adults was 5.3% of total energy intake from SSB, while African-Americans and Mexican Americans consume 8.6% and 8.2%, respectively (Ogden et al., 2011). The mean daily energy intake from SSBs in non-Hispanic white adults aged  $\geq 20$  years old in 2010 was 64 kcal/day ( $\pm 5$ ), and 108 kcal/day ( $\pm 9$ ) for African-Americans and 83 kcal/day ( $\pm 5$ ), for Mexican Americans, respectively. (Kit et al., 2013) The odds of African-American and Hispanic adults of consuming any SSB on a given day are 1.89 ( $\pm 0.09$ ) and 1.25 ( $\pm 0.06$ ) higher than non-Hispanic whites. The odds of consuming any soda and fruit drinks are also significantly higher among African American adults (soda: 1.32  $\pm 0.08$ ; fruit drinks 2.73  $\pm 0.18$ ), while the odds of consuming any fruit drinks are higher among Hispanics (1.62  $\pm 0.12$ ) compared to non-Hispanic Whites (Han & Powell, 2013). Furthermore, despite the overall decrease in SSB consumption in the U.S. in recent years, evidence suggests that the decrease is more pronounced among non-Hispanic Whites than African Americans and Hispanics. The decrease in trend over time in energy intake from SSBs from 1999 to 2010 was only significant in non-Hispanic White adults (81  $\pm 7$  kcal/day in 1990 to 64  $\pm 5$  kcal/day in 2000,  $p$  trend  $< 0.05$ ), and the decrease in trend was found to be insignificant among African Americans (116  $\pm 10$

kcal/day in 1990;  $108 \pm 9$  kcal/day in 2000) and Mexican Americans ( $116 \pm 10$  kcal/day in 1990;  $83 \pm 5$  kcal/day in 2010) (Kit et al., 2013).

Studies on SSB consumption among Asians or Asian Americans have been limited to date. Despite the rapid population growth and disparate risk profile in obesity and other chronic diseases among Asians compared to other ethnic groups in the U.S.(Jacob & Cho, 2010), most national surveys, including NHANES that were conducted before 2011, do not provide adequate representation of individuals of Asian descent to assess the ethnic differences of these various health-related issues(Ogden et al., 2013). One large cohort study of Asian adults was conducted in Hawaii, which demonstrated that the percentage of calories from carbohydrate intake had increased from 34% to 55% from 1975 to 2001(Maskarinec et al., 2006). Another study that assessed regular soda consumption among adults in New York City included Asian/Pacific Islander as a race in their analysis, but found that the odds of increased SSB consumption among this group were not significant compared to whites (OR: 1.0 [0.8-1.4]) (Rehm, Matte, Van Wye, Young, & Frieden, 2008). Despite these recent attempts by researchers to include more Asians in their sample population and analysis in obesity and dietary pattern-related studies, there still exists a paucity of studies for Asian Americans in this area (Ogden et al., 2013; Ogden et al., 2014).

A small number of studies have specifically assessed the consumption of SSB among Asians living in Asia, and the overall self-reported consumption is relatively low among Chinese living in Hong Kong and Singapore (Ko et al., 2010; Odegaard, Koh, Arakawa, Yu, & Pereira, 2010), while SSB consumption seems to be higher among Koreans living in South Korea (Han, Kim, & Powell, 2013; H. S. Lee, Duffey, & Popkin,

2012). In the Hong Kong study assessing SSB consumption among Chinese adults, frequent SSB consumption was defined as “daily intake of two or more units”, and among the 4,629 individuals, only 20.5% (471) of men and 9.5% (222) of women were found to be frequent SSB consumers (Ko et al., 2010). Among the 43,580 individuals in the Singapore prospective cohort study assessing the association between SSB, type II diabetes mellitus and weight gain, 32,060 (73.6%) of all individuals reported they “almost never” consume any soft drinks at baseline, and only 4,617 (10.6%) reported they consume 2 or more soft drinks per week (Odegaard et al., 2010). Based on a 24-hour food recall questionnaire from a nationally represented survey in Korea, the data showed that the prevalence of SSB consumption increased from 66% to 69% among young adults (aged 18-34) and 63% to 70% among adults between 2001 and 2009. While regular soda has been the most prevalent SSB in the U.S., “miscellaneous” beverages, including sports/energy drinks, coffee/tea, flavored milk, were the most frequently consumed in S. Korea among adults and the elderly (Han et al., 2013). Furthermore, contrary to the U.S. in which lower socioeconomic status was associated with increased SSB consumption (Bleich et al., 2009; Han & Powell, 2013; Ogden et al., 2011; Rehm et al., 2008), higher income and educational level appears to be a risk factor for SSB consumption in South Korea (Han et al., 2013). There was a similar finding in one study in South India in which adults in the middle income group consumed higher amounts of total energy as well as sugar compared to the lower income group (Mohan et al., 2001).

### **2.1.6 Acculturation, Dietary Patterns, and SSB Consumption among Asian Americans**

U.S. demographics have shifted dramatically in the past few decades while the consumption of SSBs and the prevalence of obesity were on the rise. The U.S. had seen a dramatic increase of immigrant populations from Asian countries during this period, and the U.S. Census Bureau found that the Asian population increased four times faster from 2000 to 2010 when compared to the total U.S. population growth. According to the definition used in the 2010 U.S. Census, Asian refers to “a person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent.” The 2010 American Community Survey estimated the total number of foreign born in the U.S. to be around 40 million (13% of total U.S. population), of which 28% were born in Asia (Census Bureau, 2012b). Asians are now the fastest growing ethnic group in the U.S. with a total population of 17 million in 2010 from 10.2 million in 2000 (Census Bureau, 2012a). As a consequence of this shift in demographics and the increasing number of immigrants living in the U.S., the influence of acculturation, defined as the process by which cultural patterns /changes (i.e. beliefs, behavior, values, attitudes, customs) that occur when individuals are exposed to another culture” (Berry, Phinney, Sam, & Vedder, 2006; Clark, 1998; Schwartz, Unger, Zamboanga, & Szapocznik, 2010), on the risk of obesity, chronic diseases, and other health outcomes have generated much research interest in recent years.

Two main concepts have guided the theory of acculturation. In the 1960s, the process of acculturation was conceptualized as an uni-dimensional occurrence where the racial/ethnic group, usually a minority, adopts the cultures and values of the dominant

group of the larger society while their own ethnic identity/beliefs are attenuated (Gordon, 1964). More recently, however, psychologists and anthropologists have favored a more bi-dimensional model in which the retention of one's original culture can coexist and is independent of the process of adoption to the new culture (Berry et al., 2006; Schwartz et al., 2010). There is also a shift in recognizing that acculturation occurs at both the individual (micro) and group (macro) level, in which cultural changes to the new culture occurs as a whole (i.e. in ethnic enclaves or communities of people of similar ethnic/cultural backgrounds)(Berry et al., 2006; Satia-Abouta, Patterson, Neuhouser, & Elder, 2002).

Regardless of theory, health researchers have suggested a “healthy immigrant effect” in which immigrants are in better health at the time of migration compared to their native born counterparts in their adopted country (Frisbie, Cho, & Hummer, 2001; Lauderdale & Rathouz, 2000; McDonald & Kennedy, 2004; Stephen, Foote, Hendershot, & Schoenborn, 1994). However, studies have demonstrated that this protective effect attenuates with increased acculturation in the new country and eventually level off with their native- born counterparts (Ayala, Baquero, & Klinger, 2008; Chen, Juon, & Lee, 2012; Goel, McCarthy, Phillips, & Wee, 2004; Kandula et al., 2008; Koya & Egede, 2007; Lassetter & Callister, 2009; McDonald & Kennedy, 2004; Novotny et al., 2012; Yang, Chung, Kim, Bianchi, & Song, 2007). A number of studies on Asian Americans have also demonstrated the positive associations of acculturation and chronic disease risks, including diabetes, hypertension, and other cardiovascular diseases(Kandula et al., 2008; Raj, Ganganna, & Bowering, 1999; Teppala, Shankar, & Ducatman, 2010;



Ueshima et al., 2003; Venkatesh, Weatherspoon, Kaplowitz, & Song, 2013; Yang et al., 2007).

Results from studies which examined the association between obesity and acculturation among immigrants to the U.S. have consistently demonstrated an increased BMI with a higher level of acculturation, regardless of how acculturation was measured (Barcenas et al., 2007; Kaplan, Huguette, Newsom, & McFarland, 2004; Novotny, Williams, Vinoya, Oshiro, & Vogt, 2009; Roshania, Narayan, & Oza-Frank, 2008; Wolin, Colangelo, Chiu, & Gapstur, 2009). Studies focusing specifically on Asian Americans (or have included Asians as a separate race group) have also confirmed this positive association between body mass index (BMI) and acculturation (Chen et al., 2012; Goel et al., 2004; Maskarinec et al., 2006; Sanchez-Vaznaugh, Kawachi, Subramanian, Sanchez, & Acevedo-Garcia, 2008).

The association between acculturation and dietary behavior among Asian Americans, however, has been less clear. Evidence suggests that immigrants have adopted some healthy dietary behavior, such as increased whole grains and fruits and vegetables uptake (Lesser, Gasevic, & Lear, 2014; Liu, Berhane, & Tseng, 2010; Lv & Cason, 2004; S. Y. Park, Murphy, Sharma, & Kolonel, 2005), but also some unhealthy ones, such as higher consumptions of fats, carbohydrates, red meats, and overall energy intake among those who are more acculturated (Liu et al., 2010; Lv & Cason, 2004; Maskarinec et al., 2006; S. Y. Park et al., 2005; Y. Park et al., 2011; Pierce et al., 2007; Rosenmoller, Gasevic, Seidell, & Lear, 2011; Satia et al., 2001). Liu et al demonstrated that higher levels of acculturation among Chinese women living in the U.S. had improved dietary variety (OR 2.4; 95% CI: 1.0-2.6), but had lower dietary moderation (OR: 0.6;

95% CI: 0.4-0.9), and therefore higher acculturation was found to be not associated with an improvement in the overall diet quality using the Diet Quality Index- International Score (Kim, Haines, Siega-Riz, & Popkin, 2003; Liu et al., 2010). One study also found that Chinese immigrants with longer duration of residence in Canada consumed larger portion sizes (OR: 9.9; 95% CI: 3.11-31.1) and dined out at restaurants more frequently (OR: 15.8; 95% CI: 5.0-49.85) compared to more recent immigrants (Rosenmoller et al., 2011).

Fewer studies have specifically examined the association between acculturation and SSB consumption among Asian adults and their findings have been inconsistent. Lesser et al demonstrated that the 35.5% of South Asians in his study reported an increase in the frequency of soft drink consumption after immigration to Canada (Lesser et al., 2014). Other studies have also found a positive relationship between fries and soda consumption (S. Wang, Quan, Kanaya, & Fernandez, 2011), regular soda consumption (Lv & Cason, 2004), and sweetened drinks (Novotny et al., 2012) with increased acculturation, while others have found a negative or insignificant association between SSB and acculturation (S. Y. Park et al., 2005; Song et al., 2004). Wang et al used the 2005 and 2007 California Health Interview Surveys and found that the odds of consuming fries and soda were 2.11 times higher (95% CI: 1.25-3.35) in more acculturated Asian (Chinese, Vietnamese, and Korean) men and 2.38 times higher (95% CI: 1.41-4.01) among women (S. Wang et al., 2011). However, as with most existing publications that included multiple Asian races in the analysis, this study did not stratify their analysis by the three difference races when assessing SSB consumption.

There has also been much debate among health researchers and social scientists on how acculturation should best be measured (Andrews, Bridges, & Gomez, 2013; Ayala et al., 2008; Chakraborty & Chakraborty, 2010; Salant & Lauderdale, 2003; Satia et al., 2001; Satia-Abouta et al., 2002). A number of studies conducted around acculturation measurements have focused on the Latino population (Gordon-Larsen, Harris, Ward, Popkin, & National Longitudinal Study of Adolescent Health, 2003; Hunt, Schneider, & Comer, 2004; Siatkowski, 2007; Suarez & Pulley, 1995; Thomson & Hoffman-Goetz, 2009; Wallace, Pomery, Latimer, Martinez, & Salovey, 2010), and less emphasis has been placed among Asian Americans (Baker, 2011; Salant & Lauderdale, 2003; Serafica, 2011; Siatkowski, 2007). The lack of clarity in these findings may be a result of a lack of consistent definition and measurement of acculturation around Asian Americans in existing literature. A literature review conducted by Salant et al provided a critical examination of publications on acculturation and health among Asian immigrants. It was found that most health researchers, when studying health outcomes or behaviors, tend to rely on non-scaled survey instruments, or the use of one or two proxy measures such as generation status, length of time in the U.S., and/or use of English, in their studies (Baker, 2011; Salant & Lauderdale, 2003). Examples of single continuum measurements used among Asians include the Acculturation Scale for Southeast Asian and the Lew Asian Self-Identity Acculturation Scale and more recently, the Asian Values Scales and European American Values Scale for Asian Americans were used (Beck, 2006; Wolfe, Yang, Wong, & Atkinson, 2001; Yamada, Marsella, & Yamada, 1998). However, critics caution the use of either overall composite scores or single proxy measures as they often are inadequate in capturing the complexity or the degree of acculturation (Baker, 2011; R.

Lee, Eunju, & Liu-Tom, 2006; Salant & Lauderdale, 2003). Researchers note that more research is needed to understand the different dimensions on how acculturation affects health, value, and behavior in the lives of immigrants (Baker, 2011; R. Lee et al., 2006).

### **2.1.7 Neighborhood Racial/Ethnic Density, Health, and Behavior**

Resources and health risks are often spatially and socially structured. Ethnic minorities, especially those who reside in neighborhoods with high concentrations of minorities and/or economically disadvantaged neighborhoods, are disproportionately affected (Bleich, Thorpe, Sharif-Harris, Fesahazion, & Laveist, 2010; Do et al., 2007; Dubowitz, Subramanian, Acevedo-Garcia, Osypuk, & Peterson, 2008; Giskes, Avendano, Brug, & Kunst, 2010; Kershaw et al., 2011; Kershaw, Albrecht, & Carnethon, 2013; Landrine & Corral, 2009; Larson et al., 2009; Larson, Story, & Nelson, 2009; LaVeist, 2005; Mujahid et al., 2008; Zenk et al., 2005). As a result, there is an increased focus to determine how residential environment affect health, healthy behaviors and its contribution to racial health disparities. There is now a growing body of literature that associates adverse dietary behaviors and diet-related health outcomes with residence in high minority concentration neighborhoods and/or economically disadvantaged neighborhoods, after controlling for individual sociodemographic characteristics (Bleich et al., 2010; Borrell, Kiefe, Diez-Roux, Williams, & Gordon-Larsen, 2013; Kershaw et al., 2013; Landrine & Corral, 2009; Mujahid et al., 2008; Reyes-Ortiz, Ju, Eschbach, Kuo, & Goodwin, 2009; Robert & Reither, 2004).

Research conducted in the area of sociology and demography over the past few decades has demonstrated that immigrants and ethnic minorities are more likely to reside in neighborhoods with other residents from the same or similar ethnic groups and/or with

high proportions of other immigrants (Kritz, Gurak, & Lee, 2013; J. Logan, 2011; J. Logan & Stults, 2011; Massey & Denton, 1988; Van Hook & Glick, 2007; Wen, Lauderdale, & Kandula, 2009). The largest body of literature to date concerned the effect of racial/ethnic segregation on health among African American adults, with a relatively consistent finding on its negative association (Jackson, Anderson, Johnson, & Sorlie, 2000; Kramer & Hogue, 2009; Kramer, Cooper, Drews-Botsch, Waller, & Hogue, 2010; Landrine & Corral, 2009; Subramanian, Acevedo-Garcia, & Osypuk, 2005). It has shown that African Americans living in more segregated neighborhoods have limited healthy food options (Galvez et al., 2008; Larson et al., 2009; Moore & Diez Roux, 2006; Zenk et al., 2005), consume less fruits and vegetables (Corral et al., 2012), and are at higher risks for overweight and obesity (Chang, 2006; Corral et al., 2012; Kershaw et al., 2013; Robert & Reither, 2004).

Findings regarding ethnic segregation and health for Hispanic American adults are less consistent compared to African Americans and research on Asians in this area is limited (Acevedo-Garcia, 2001; Acevedo-Garcia, Lochner, Osypuk, & Subramanian, 2003; Eschbach, Ostir, Patel, Markides, & Goodwin, 2004; Gee, 2002; Kershaw et al., 2013; Kramer & Hogue, 2009; M. A. Lee & Ferraro, 2007; Osypuk, Diez Roux, Hadley, & Kandula, 2009; Patel, Eschbach, Rudkin, Peek, & Markides, 2003; Reyes-Ortiz et al., 2009). Evidence suggests that neighborhoods with high concentration of Mexican Americans had four times the number of convenience stores compared with less concentrated neighborhoods (Lisabeth et al., 2010), and Mexican-Americans residing in these high- concentration neighborhoods consume less fruits and vegetables (Reyes-Ortiz et al., 2009). However, in other studies, it was found that Hispanics living in immigrant

enclaves had better diet quality (Osypuk et al., 2009), and that Mexican American women living in highly segregation areas (with high Hispanic isolation index) had a lower obesity prevalence (prevalence ratio, 0.54, 95% CI: 0.33, 0.90)(Kershaw et al., 2013). A systematic review conducted by Becares et al demonstrated that neighborhoods with higher composition of Hispanics to be protective in regards to infant mortality, birth weight, and smoking during pregnancy, but the associations with health behaviors, including dietary patterns and nutrition, were less salient (Becares et al, 2012).

Evidence on Asian Americans in the association of racial/ethnic composition and dietary behavior is very limited. One study found that the Chinese living in neighborhoods with a higher proportion of foreign-born Hispanics and Chinese had lower intake of high-fat and processed foods ( $p < 0.003$ ) and had marginally better health food environments ( $p = 0.06$ ) (Osypuk et al., 2009). To date, no study has assessed the association of ethnic neighborhoods with SSB consumption among Asians living in the United States.

## **2.2 CONCEPTUAL FRAMEWORK**

The reasons for differences and ethnic disparities in dietary behaviors among populations are complex. Booth et al conceptualized a framework that incorporated policy, social and environmental factors that affected food choices and healthy behaviors (**Figure 2.2**) (Booth et al., 2001). It demonstrates a complex overlay between these various levels of factors and how they may be interlinked with one another and affect an individual's behavior that could potentially contribute to the ethnic disparities in food choices and other related modifiable behaviors.

Based on the review on past literature and existing frameworks, a conceptual framework was developed for this study to demonstrate the associations between neighborhood and individual level factors and SSB consumption. The study- specific conceptual framework is shown in **Figure 2.3**.

## **2.3 RESEARCH METHODS**

### **2.3.1 Design and Study Population**

#### ***The 2009 California Health Interview Survey***

The California Health Interview Survey (CHIS) is the largest population-based survey conducted in any state, and is one of the largest health surveys in the U.S. It is a cross-sectional population-based telephone survey conducted every other year since 2001 among non-institutionalized residents living in California. The 2009 CHIS is sponsored by the California Department of Public Health (CDPH), the Department of Health Care Services (DHCS), and the University of California, Los Angeles Center for Health Policy Research (CHPR). Its questionnaire focuses on health status and conditions, health-related behaviors, health insurance coverage, and access to health care services in populations of all ages residing in California (Cervantes & Brick, 2011). The survey is divided into the child and adult components and only the adult component of the 2009 was used in this study.

The 2009 CHIS used a multi-stage sample design and the random-digit-dial (RDD) sample included both cellular and landline telephone services, which included 44 geographic sampling strata. Koreans and Vietnamese were oversampled based on surnames in order to increase the sample size and precision of estimates for these populations. The study population includes all adults aged 18 or older residing in

California at the time of the interview. Individuals who were pregnant at the time of the interview, and those who do not provide information on self-reported race/ethnicity, or any information on eating patterns were excluded from this analysis.

### ***2010 U.S. Census Data***

The 2010 Census is a decennial population census which captures the actual count of the population of the U.S. Data from census tracts were merged with the 2009 CHIS to identify the approximate area of residence for survey respondents in order to examine the associations of neighborhood racial concentration and SSB consumption in specific aim 3 this is a run on sentence – split into two. Census tracts average about 4,000 persons per tract and are the third smallest statistical subdivisions subdivision within the census summary levels. They are, by design, used to represent populations that are relatively homogeneous in regards to sociodemographic characteristics and living conditions. (Census Bureau, 2012b)

### ***2009 Census Business Data***

The Statistics of U.S. Businesses data are collected annually by the U.S. Census Bureau. The 2009 dataset which contained census zip level data on business classifications based on the North American Industry Classification System (NAICS), the standards used by the Federal statistical agencies to classify U.S. business establishments, were used in this study to determine the number of food stores and restaurants for specific aim 3.



### **2.3.2 Analytical Methods**

The 2009 CHIS is a multistage survey with a complex sample design and structured data, and the results from these surveys need to take into account the issue of design effects. To produce population estimates from the CHIS data, weights were incorporated to the analysis of this study in order to accurately compensate for the probability of the sample selection. The sample was weighted to represent the non-institutionalized population for each sampling stratum and statewide using the paired unit jackknife method, a form of jackknife replication, for variance estimations. All analyses were conducted using STATA 11 and all hypothesis testing was two-sided, with  $\alpha=0.05$ . Three major statistical approaches were used in this study as described in the following sections and are also discussed in the methods sections, as appropriate, in **Chapters 3 to 5**.

#### **2.3.2.1 Exploratory and Descriptive Data Analysis**

Graphical and non-graphical exploratory data analyses were conducted. The purpose of this approach was to determine relationships among the explanatory variables and to examine their distribution properties including range, centrality, spread and distribution, outliers, and skewness. For graphical analyses, histograms, box plots, and stem-and-leaf plots were used to assess frequency distributions, missing data, normality and outliers for all key variables. In addition, scatterplots and lowess smooth curves were used to examine the unadjusted relationships between the dependent and independent variables. In regards to non-graphical exploratory data analysis, summary measures and new categorical variables were created. All continuous variables were centered and some were mathematically transformed such that their distributional

properties are consistent with assumptions used in estimation and hypothesis testing. Descriptive statistics were conducted to examine the means, medians, ranges and standard deviations of all key variables. Finally, significance testing for group differences was performed using chi square test for categorical variables and analysis for variance (ANOVA) for continuous variables in this study. Univariate analyses were conducted to determine the unadjusted associations between key independent variables and with the dependent variable.

### **2.3.2.2 Multivariate Logistic Regression Analysis and Modeling**

Multivariate linear regression analysis was originally used in specific aim 1 to assess the continuous relationship between ethnic differences and SSB consumption frequencies. However, the presence of heteroscedasticity in the multivariate linear regression model, despite efforts with mathematical transformations of key variables, invalidated the homogeneity of variance assumption in linear regression modeling.

As a result, multivariate logistic regression was selected for the study because it does not assume a linear relationship between the dependent and independent variables, and normal distribution of the dependent variable is not required. But most importantly, the equal variance assumption does not apply to logistic regressions. The logistic model specification used in this study is as follows:

$$\log\left(\frac{p_i}{1 - p_i}\right) = \beta_{0i} + \beta_1 X_{1i} + \beta_2 X_{2i} + \sum_{i=1}^m \beta_m X_{mi} + \varepsilon_i$$

Where  $p_i$  is the individual's probability of SSB consumption,  $i$  represents the individual,  $X_i$  is a specific measured explanatory variable, such as gender,  $\beta_i$  is the beta coefficients

representing the change in  $\log\left(\frac{p_i}{1-p_i}\right)$  per unit change in  $X_i$ , and  $X_m$  is any other explanatory variable such as age, marital status, and educational attainment.

As part of the modeling process, univariate regressions were first performed to assess the unadjusted relationship between the exposure and outcome variables. Specific covariates were then included to the unadjusted models to control for other factors, such as effect modification and confounders. Covariates that were considered in the model included sociodemographic variables such as poverty, age, gender, marital status, educational attainment, dietary behaviors, lifestyle factors, and morbidities including self-reported health status, diabetes, fruits and vegetable intake, physical activity, and smoking status.

### **2.3.2.3 Factor Analysis**

Factor analysis (FA) is a multivariate statistical method used to identify patterns of correlations among many observed variables to fewer variables through covariance matrices (Cattell, 1965). Factors, therefore, are extracted by linear combinations of the original variables that capture the various underlying dimensions through covariance matrices. For specific aim 2, factor analysis was applied on all of the 10 acculturation-related questions in the 2009 CHIS to identify the various dimensions of acculturation on the basis of their inter-correlations. Factors were then extracted based on the number of components having eigenvalues greater than 1.0 to account for the amount of variance in each factor and the percentage of total variance explained. Scree plots and parallel analysis were performed to determine the number of components to be included in the final model. Each retained component was orthogonally rotated with a varimax rotation

to provide orthogonal factors. Factor score for each retained component was then calculated into a summary measure of acculturation based on the component loading weights and was normalized with a mean of zero and a standard deviation of one. The final factors scores were included as variables in the subsequent multivariate logistic regression modeling in specific aim 2.

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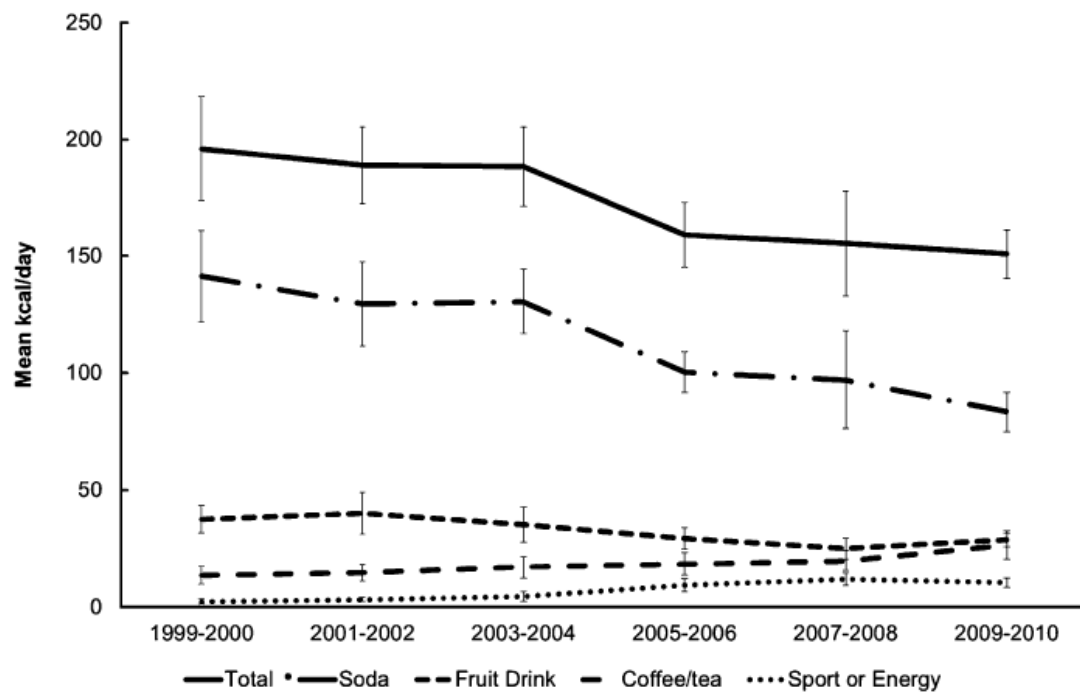
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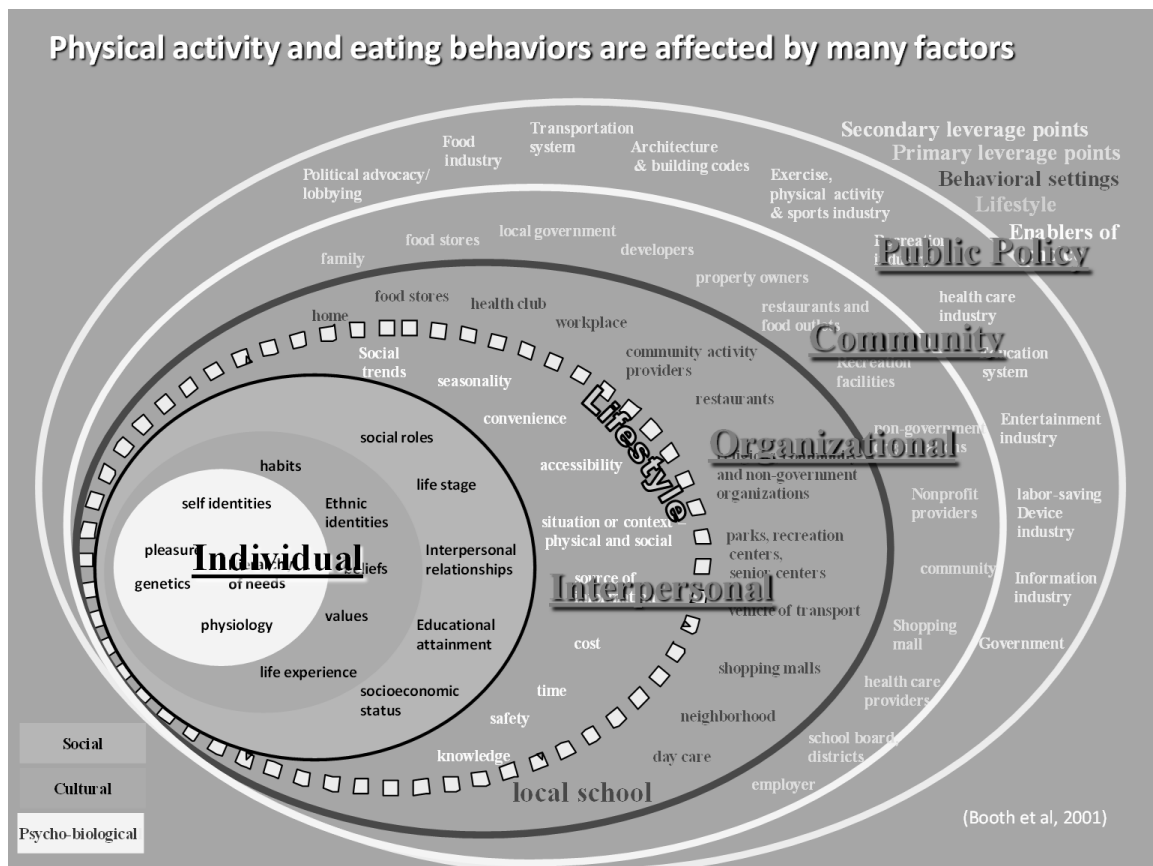
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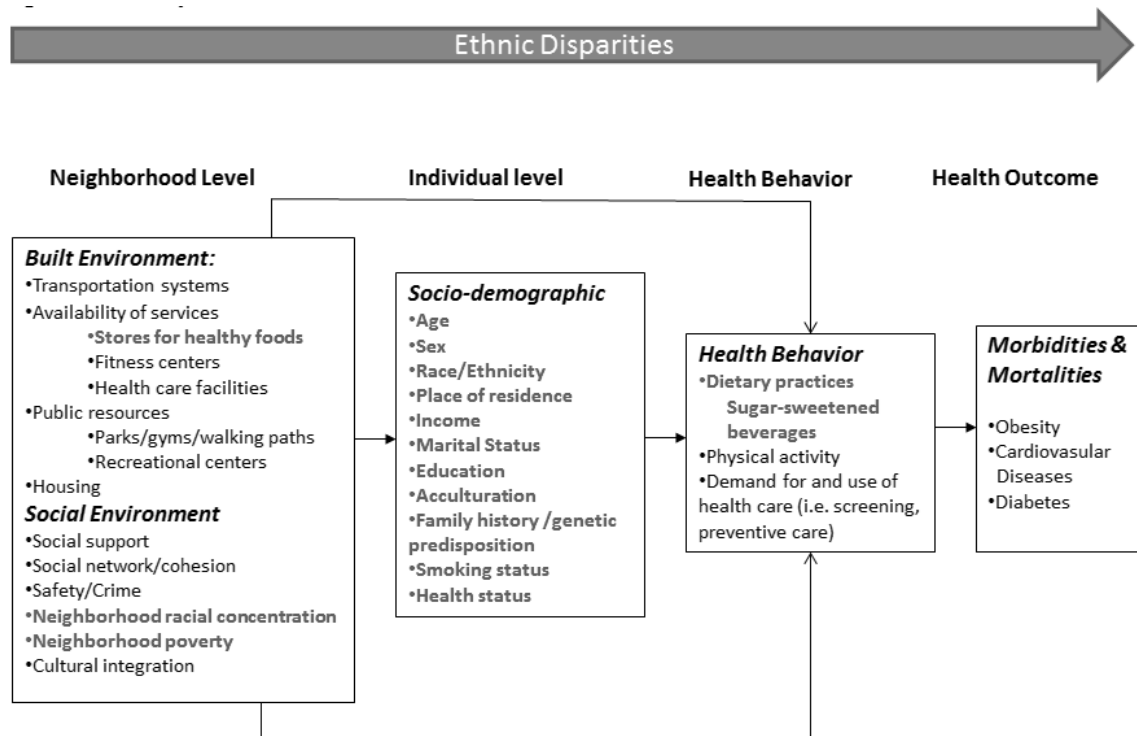
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**Figure 2.1 Trends in sugar-sweetened beverage consumption among adults  $\geq 20$  years old in the United States, by type of beverage (Kit et al., 2013).**



**Figure 2.2 Conceptual framework for determinants of eating behavior and physical activity (Booth et al., 2001)**



**Figure 2.3 Conceptual framework for associations between individual and neighborhood level factors and sugar-sweetened beverage consumption**



### **CHAPTER 3: ETHNIC DIFFERENCES AMONG ASIAN AND NON-ASIAN ADULTS IN THE CONSUMPTION OF SUGAR-SWEETENED BEVERAGES IN CALIFORNIA**

#### **ABSTRACT**

**Background:** Sugar-sweetened beverages are positively associated with the increased risk of obesity and higher body weight and have been an area of obesity-related policy debate in recent years. However, little information is available regarding the patterns of SSB consumption among Asians adults living in the U.S.

**Objectives:** To describe 1) the ethnic differences in the amount and types of SSB consumed among Asians, Hispanics, African American, and Other Races adults compared with non-Hispanic White adults residing in California, and 2) the patterns in the frequency and types of SSB consumption among the different Asian subpopulations in California

**Methods:** This study is a cross-sectional analysis of 47,397 adults aged 18 or older (including a subsample of 5,062 self-reported Asians) who participated in the 2009 California Health Interview Survey. Race/ethnic stratified regression analyses for overall SSBs consumption frequency (and by types of beverage) were conducted. Key individual level factors that affect one's SSB consumption frequency were identified.

**Results:** The odds of Asians who consumed any SSB in the past week were similar to Whites (OR: 1.2, 95% CI: 0.9-1.4,  $p < 0.05$ ), while it was significantly higher for African Americans, Hispanics, and Other races. Significant differences in the frequency and the type of SSB consumed among the Asian subpopulations were observed. The odds of Filipino (OR: 1.9, 95% CI: 1.3, 2.8,  $p < 0.01$ ), Vietnamese (OR: 1.6, 95% CI: 1.0-2.4,

$p < 0.05$ ), and South Asian (OR: 2.0, 95% CI: 1.3-2.9,  $p < 0.01$ ) adults consuming a total of  $\geq 3$  SSB per week were significantly higher compared to Chinese. The predicted marginals also suggest that coffee/tea appears to be the driver of SSB consumption among Asians.

**Conclusion:** Our results indicate that race/ethnicity is independently associated with SSB consumption among U.S. adults living in California after adjusting for sociodemographic and lifestyle behavioral factors. Our findings suggest that policies and nutrition programs aimed at reducing SSB among Asians should focus on coffee/tea consumption and be cognizant of the disparate SSB consumption patterns within different Asian subpopulations when designing these programs for Asians living in the U.S.

## INTRODUCTION

Evidence from national surveys conducted in the U.S. suggests that the self-reported amount of foods and beverages, total energy intake, and the amount of foods and calories per eating episode have experienced an increase in secular trend between 1977-2002 (Kant & Graubard, 2006). At the same time, the consumption of added sugars and sugar-sweetened beverages (SSB) in the U.S. has increased dramatically, and its temporal patterns are parallel to the rise in obesity (Bleich, Wang, Wang, & Gortmaker, 2009; Han, Kim, & Powell, 2013; Malik, Schulze, & Hu, 2006; Malik et al., 2010; Qi et al., 2012). Between 1977 and 2001, the percent of calories from all beverages in the U.S. increased by more than 50% while the prevalence of obesity among U.S. adults doubled (Duffey & Popkin, 2007; Flegal, Carroll, Ogden, & Johnson, 2002). While most recent data suggest that the increases in the population prevalence of obesity previously observed may not be continuing at a similar rate, there is no indication that the prevalence of obesity is declining in the U.S. (Flegal, Carroll, Kit, & Ogden, 2012; Ogden, Carroll, Kit, & Flegal, 2014), and regular soda consumption continues to be the leading food source of added sugars for adults aged 18–54 (Kit, Fakhouri, Park, Nielsen, & Ogden, 2013; Ogden, Kit, Carroll, & Park, 2011; Welsh, Sharma, Grellinger, & Vos, 2011).

The disproportionate effects of obesity, SSB consumption, and other chronic conditions such as diabetes and cardiovascular diseases among African Americans and Hispanics have been well studied (Duffey & Popkin, 2007; Flegal et al., 2012; Hu & Malik, 2010; Malik et al., 2010; Malik, Popkin, Bray, Despres, & Hu, 2010; Ogden et al., 2014; Wang & Beydoun, 2007). Recent data from the National Health and Nutrition Examination Survey (NHANES) have demonstrated that African American and Mexican

American adults aged 20 or older consumed higher SSB kilocalories as a percent of their total caloric intake (Kit et al., 2013; Ogden et al., 2011). Bleich et al (2009) have also demonstrated that young African Americans had the highest per capita consumption of SSB compared with White and Mexican American adults (Bleich et al., 2009). However, these associations are not well studied among Asian adults living in the U.S. Despite the rapid population growth and disparate risk profile in obesity and other chronic diseases among Asians compared to other ethnic groups in the U.S. (Jacob & Cho, 2010), most national surveys, including NHANES that were conducted before 2011, do not provide adequate representation of individuals of Asian descent to assess the ethnic differences of these various health-related issues (Ogden, Carroll, Kit, & Flegal, 2013; Ogden et al., 2014). One large cohort study of Asian adults conducted in Hawaii demonstrated an increase in the percentage of calories from carbohydrate intake from 34% to 55% from 1975 to 2001 (Maskarinec et al., 2006). However, despite recent attempts by researchers to include more Asians in their sample population and analysis in obesity and dietary pattern-related studies, there still exists a paucity of studies for Asian Americans in this area (Ogden et al., 2013; Ogden et al., 2014).

A small number of studies have specifically assessed the consumption of SSB among Asians living in Asia (Ko et al., 2010; Odegaard, Koh, Arakawa, Yu, & Pereira, 2010). To date, only one published study was conducted among Chinese immigrants residing in Pennsylvania, which demonstrated that the consumption of SSB after immigration was significantly higher compared to before arriving in the U.S. (Lv & Cason, 2004). Given the fact that changes in health and dietary behavior among adult immigrants become more similar to U.S. born adults (Goel, McCarthy, Phillips, & Wee,

2004; Gordon-Larsen, Harris, Ward, Popkin, & National Longitudinal Study of Adolescent Health, 2003; Nielsen & Popkin, 2004) and that sugar sweetened soft drinks are now the largest source of added sugars in the U.S.(Welsh et al., 2011), it is important to assess the consumption of SSB, one of the key proxies in measuring diet quality, in this fastest growing minority population (Census Bureau, 2012).

Several studies have investigated the associations between SSB and various dietary behaviors and found that increased SSB consumption is associated with poorer diet quality (Odegaard, Choh, Czerwinski, Towne, & Demerath, 2012; Qi et al., 2012; Vartanian, Schwartz, & Brownell, 2007). Evidence suggests an association between increased SSB consumption and poorer diet quality in adults, such as the displacement of nutrient-dense foods, lower intakes of macronutrients and fiber, and greater estimated energy and carbohydrate intake with increased SSB consumption (Odegaard et al., 2012; Vartanian et al., 2007). Another study demonstrated that adults with higher SSB consumption had lower scores on the Alternative Healthy Eating Index, an index measuring diet quality, and a higher total energy intake (Qi et al., 2012). Therefore, it is important to understand the patterns of SSB consumption as it can be a useful proxy to assess one's diet quality and eating behaviors.

The purpose of this study, therefore, describes 1) the racial/ethnic differences in the frequency and types of SSB consumed among Asians, Hispanics, African American, and Other Races adults compared with non-Hispanic White adults residing in California, and 2) the patterns in the frequency and types of SSB consumption among the different Asian subpopulations in California--which to our knowledge, has yet to be assessed. We hypothesize that 1) the consumption of SSB among Asians will be lower than their

Hispanic and African American counterparts; and 2) patterns of SSB consumption will be significantly different among the various Asian subpopulations. The results of this study will provide new insight into SSB consumption among Asians compared to other races. In addition, the findings will help better target interventions in ethnic minorities, especially among Asian subgroups, in the reduction of SSB, and possibly offering a more effective solution in curtaining unhealthy dietary behavior and weight gain in these populations.

## **METHODS**

### **Study design and data**

For this study, data from the adult component of the 2009 California Health Interview Survey (CHIS) was used to examine the extent of racial/ethnic disparities in SSB consumption among adults living in California. CHIS 2009 is a population-based survey and is the largest health survey ever conducted in any state. The 2009 CHIS surveyed 47,614 adults using a two-stage geographically stratified random digit dial (RDD) sample design. It was designed to provide estimates for California's overall population, including its major racial and ethnic groups and several key Asian subgroups. A complete description of data collection methods is available elsewhere. (<http://www.askchis.com/designs-methods.html>)

### *Study Sample*

The study sample consists of all non-institutionalized adults aged  $\geq 18$  years old residing in California at the time of the interview, between September 2009 and April 2010. The diverse ethnic composition in California makes the CHIS a useful instrument to study ethnic disparities beyond African American and Hispanic populations. Survey

respondents were excluded if they were pregnant at the time of data collection. A final sample of 47,397 adults was used in the analyses.

## **Measures**

### *Sugar-sweetened beverages (SSB)*

For sugar-sweetened beverages, this study included carbonated soft drinks, sugar-sweetened coffee and tea, and noncarbonated SSB such as fruit punches, lemonade, energy drinks and sports drinks. Survey respondents reported on how often they consumed the following four types of SSB: soda, flavored fruit drinks, sports drinks, and coffee/tea. Respondents had the option of answering by either the number of times per day, per week, or per month, but all of the responses were converted to number of times per week for the analyses. Flavored drinks and sports drinks were combined into one variable since the frequency of consumption for these two types of beverages were relatively low compared to soda and coffee/tea consumption.

Outcome responses for the total consumption of SSB were categorized by the amount of sweetened beverages they consumed into 1) none per week or 2) any consumption per week and 3) >3 occasions of consumption per week. Diet beverages and unsweetened coffee/tea were not included in these analyses.

### *Health behavior*

Physical activity was divided into three categories: low, moderate, and vigorous, based on the number of times per week that the respondent reported engaging in physical activities. Fruits and vegetables intake per week and fast food consumption per week were included as continuous variables in the analyses. General health status was

categorized into poor/fair, good, and very good/excellent. Self-reported diabetes status was categorized into diabetes, pre-diabetes/borderline, and no diabetes.

#### *Race, ethnicity and nativity*

Race and ethnicity were categorized based on the 1997 Office of Management and Budget (OMB) standards for vital records collection into 1) non-Hispanic White, 2) Hispanic, 3) non-Hispanic Black, 4) non-Hispanic Asian, and 5) Other Races, for merged groups that had small sample sizes including Pacific Islanders, American Indians, Alaskan Natives, and those who identified two or more races.

In the analysis of the Asian subpopulations, all individuals who were self-reported as one of the Asian subgroups (Chinese, Japanese, Korean, Filipino, South Asian, Vietnamese, Southeast Asians, and Other Asians) were included in the analysis. Southeast Asians were grouped into “Other Asians” due to its small sample size. Nativity (U.S. vs. foreign born) was also included in this study.

#### *Sociodemographic status*

Age was categorized into 18-39, 40-59, and 60 years old or above and marital status was classified into three categories (married/living together, separated/divorced/widowed, never married). Four educational attainment categories were considered: master’s degree or higher, college graduate, high school graduates/some college, and less than high school. Four family income levels expressed as percentages of the federal poverty level (FPL) of  $\geq 300\%$ , 200-299%, 100-199%, and  $\leq 99\%$  were included.

### **Statistical Analysis**



All analyses were weighted to be representative of the non-institutionalized adult population in California and were conducted using STATA version 11 (Stata Corp, College Station, TX). In order to account for the complex sampling structure, jackknife variance estimation method was used to compute and adjust for the standard error estimates.

Bivariate associations between the four categories of SSB (total SSB, soda, coffee/tea, flavored/sports drinks) and covariates were tested using chi-squared tests or one-way analysis of variance. Tests for interaction between sex and race, sex and age, education and race, and poverty and race were included in the analysis.

Multivariate logistic regressions were adjusted for population composition during the survey period and to identify predictors of SSB while controlling for variables on health behavior and status, acculturation and sociodemographic characteristics including sex, income, age, marital status, and education. All models were either stratified by race/ethnicity (Non-Hispanic White, African American, Hispanic, Asian, and Other) or by Asian sub-populations (Chinese, Japanese, Vietnamese, Korean, South Asian, Filipino, and Other Asian). Based on these weighted regression models, the multivariate-adjusted odds ratios and 95% confidence intervals and predicted marginals of percentage of individuals consuming 0 and  $\geq 3$  SSB per week (and by types of beverage) for each race/ethnicity and the Asian sub-groups were assessed in this study.

## **RESULTS**

### **Population characteristics**

**Table 3.1** reports the characteristics of the study sample by race/ethnicity. Overall, 47% of individuals were non-Hispanic White, with Hispanics constituting 31%, Asians 13%, and non-Hispanic African Americans 6% of the weighted population respectively. The mean age was 45.2 years old with a BMI of 26.8. Sixty- six percent had at least a high school education and 52.5% were living above 300% of the federal poverty level (FPL). There were significant differences among non-Hispanic Whites, Hispanics, non-Hispanic Asians, non-Hispanic African Americans, and Other Races with respect to sex, age, body weight status, education, marital status, poverty level, fast-food and SSB consumption.

**Table 3.2** reports the characteristics of the study sample among those adults of self-reported Asian descent. Overall, Chinese (27%), Filipino (25%), and South Asian (13%) constituted the largest percentages of Asian in the weighted sample. There were significant differences among these Asian sub-groups with respect to age, BMI, education, poverty level, and the percentage of foreign born. South Asians were significantly more educated (49% with a post-bachelor degree) and 79% were living above the 300% federal poverty level, while Vietnamese were the least educated (5% with a post-bachelor degree) with 49% living below 200% of the federal poverty level. Filipinos had significantly higher mean BMI among the Asian sub-groups.

### **Overall adult sugar-sweetened beverage consumption in California**

The adjusted odds ratios (OR) of adults consuming any SSB and  $\geq 3$  times per week by types of beverage are listed in **Table 3.3**. Consumption of SSB was significantly higher in young adults (aged 18-39) and middle-aged adults (aged 40-59) for all types of beverages and the OR of consumption was higher among men for all types of

SSB except coffee/tea. There were significantly higher risks (ORs) of African Americans, Hispanics, and Asians consuming SSB  $\geq$  three times per week compared to Whites regardless of the type of beverage. However, the percentages of Asians who consume  $\geq 5$  and  $\geq 7$  SSB per week were similar to Whites, while these percentages were significantly higher among Hispanics, African Americans, and other races compared to Whites (data not shown). Furthermore, the odds of Asians who consumed any SSB in the past week were similar to Whites, while it was significantly higher for African Americans, Hispanics, and Other Races. By beverage type, the odds of Asians who consumed any soda per week were similar to their White counterparts and it was significantly lower than Whites for  $\geq 3$  soda consumption per week. On the contrary, the odds of consuming any and  $\geq 3$  occasions of soda per week were significantly higher for Hispanics, and the odds of consuming any soda per week were significantly higher for African Americans, compared to non-Hispanic Whites.

High school graduates and individuals with less than a high school degree had higher odds of consumption of SSB for all types of beverage compared to those with a post-bachelor's degree. Overall, individuals born in the U.S. consumed less coffee or tea and the total SSB consumption of  $\geq 3$  per week were also lower compared to those who were born outside of the U.S. Consumption of SSB was significantly lower among those who have self-reported diabetes or are borderline diabetics across all types of beverages and was positively associated with fast-food consumption (data not shown). No evidence of effect modification was found in the study.

### **Consumption patterns of sugar-sweetened beverages among Asians**

Differences in the frequency and the types of SSB consumed among the Asian subpopulations were observed. The odds of Filipino, Vietnamese, and South Asian adults consuming a total of  $\geq 3$  SSB per week were significantly higher compared to Chinese. Based on results from **Table 3.4**, Filipinos consistently had higher SSB consumption across all types of SSB, while South Asians had a significantly higher consumption of  $\geq 3$  coffee or tea and soda occasions compared to Chinese. Japanese had the highest odds of  $\geq 3$  soda consumption frequency per week and the lowest odds of  $\geq 3$  coffee/tea consumption among all Asian subpopulations. Age was inversely associated with the odds of SSB consumption, but significant differences in SSB consumption by body weight category (data not shown), poverty, and place of birth were not observed.

The adjusted percentages of those who consumed  $\geq 3$  SSB by beverage type among the Asian subpopulations in **Figure 3.1** demonstrated that the percentages of individuals consuming  $\geq 3$  occasions of soda per week are relatively low across all Asian subgroups. With the exception of Japanese, sweetened coffee/tea accounts for a significant percentage of the overall SSB consumption when compared to the other types of beverages included in this study among Asians.

## DISCUSSION

Our study demonstrated that race/ethnicity is an independent predictor of SSB consumption among U.S. adults living in California after adjusting for sociodemographic and lifestyle behavioral factors. African Americans, Hispanics, and Other races adults had higher odds of consuming any SSB in the past week while African Americans, Hispanics, and Asians had greater odds of  $\geq 3$  total SSB consumption occasions per week compared to non-Hispanic Whites.

The 2010 U.S. dietary guidelines recommend limiting the consumption of foods and beverages with added sugars, and the American Heart Association recommend the consumption of no more than 450 kilocalories (equivalent of 3 cans of soda) of SSB per week (Lloyd-Jones et al., 2010). This study demonstrated that the majority of adults in California continue to consume SSB at least 3 times per week. Consistent with other published studies on SSB among the U.S. population, the odds of SSB consumption was significantly higher among male adults who were younger, consumed more fast-food, and among those who were of lower income quartiles (Bleich et al., 2009; Han & Powell, 2013; Kit et al., 2013; Ogden et al., 2011).

To date, population-based data comparing SSB consumption among Asians is limited. Our study demonstrated that while the odds of  $\geq 3$  SSB consumption occasion per week among Asians was higher compared to their non-Hispanic White counterparts, their SSB consumption was still significantly lower compared to Hispanics and African Americans. Furthermore, the fact that the percentages of Asians who consumed  $\geq 5$  and  $\geq 7$  SSB occasions per week were similar to Whites while African Americans and Hispanics continued to have significantly higher percentages of  $\geq 5$  and  $\geq 7$  SSB consumption per week compared to Whites (data not shown) reaffirms that among those who consumed SSB, the average SSB consumption occasion per week is less for Asians compared to Hispanics and African Americans.

Previous studies have shown that the primary source of SSB consumption in the general U.S. adult population comes from soda and remains the largest source of added sugar in the diet (Welsh et al., 2011). But results from this study suggest that the patterns of SSB consumption among Asians are different from other ethnic minorities in the U.S.

The odds of soda consumption occasion per week were significantly lower among Asians while there is a high level of sugar-sweetened coffee/tea consumption across most Asian subgroups. The percentages of individuals consuming  $\geq 3$  soda occasions per week were significantly lower among Asians compared to other ethnic groups. However, the percent of Asian adults consuming any coffee/tea within the past week was significantly higher compared to non-Hispanic Whites. The results suggest that coffee/tea is the main driver of SSB consumption occasion among Asians, which differs significantly from the high soda consumption pattern in the non-Asian population.

This finding has important implications for future development of targeted policies and scale up of programs in SSB reduction, particularly the highlighted differences in the types of beverage consumed among the Asian population. Policies and nutrition programs targeting SSB to date has mostly targeted soda beverages, including two recent ballot initiatives on soda tax in California in 2012 (Gollust, Barry, & Niederdeppe, 2014; Jou, Niederdeppe, Barry, & Gollust, 2014). Given the different patterns of high coffee/tea and low soda consumption among Asians, these policy approaches may be less effective in reducing SSB consumption among Asians compared to other ethnic groups, and nutrition programs that target specifically on sweetened coffee/tea intake (and first determining where they are consuming these beverages, i.e. home vs. restaurant vs. café) should be considered as an alternative to the existing mainstream programs.

Another important finding from this study was the considerable differences in SSB consumption among the various Asian subgroups. The percentages consuming at least three SSB occasion per week were significantly higher among Filipinos,

Vietnamese, and South Asians when compared to their Chinese counterparts, who on average, consumed the least amount of SSB among all Asians. Filipinos had significantly higher consumption for all types of SSB (soda, coffee/tea, sports and fruit drinks), while South Asians consumed more soda and coffee/tea compared to Chinese.

Asians, when included in nationally representative surveys, are often aggregated as one ethnic group (Kirby, Liang, Chen, & Wang, 2012; Ogden et al., 2013; Ogden et al., 2014). Of the limited studies on disaggregated Asian subgroups, there is evidence to suggest that large variations exist within Asian populations between BMI and percentage of body fat (Deurenberg & Deurenberg-Yap, 2003), and one national study from the U.S. showed that Filipino adults were two times more likely to be obese compared to South Asian, Chinese, and Vietnamese (Barnes, Adams, & Powell-Griner, 2008). This study not only demonstrated the varying differences in dietary behaviors in the form of SSB consumption among these subpopulations, but it serves as a reminder that Asians are a highly diverse population and aggregating them as one group when studying dietary behaviors should be done with caution.

While education (less than 12 years and high school graduates/some college) and poverty level (100-199% FPL and 0-99% FPL) were significantly associated with increased odds of individuals consuming SSB across all types of SSB in the overall study population (**Table 3**), this association was not observed in the Asian subgroup analyses. Poverty level had no association with SSB consumption in any of the Asian subgroups, and interestingly, having lower level of education (< 12 years) resulted in lower odds of consuming any SSB compared to those with a post-graduate degree among Asians.

Despite the high level of education among South Asians (77% with a bachelor's degree or higher), they had a relatively high level of SSB consumption, particularly with soda and coffee/tea. One study conducted in South India demonstrated that those in the middle-income group consumed higher amounts of total energy as well as sugar compared to the lower income group (Mohan et al., 2001). A systematic review of factors associated with diabetes among migrant South Asians also demonstrated that immigrants living in western countries have adopted a diet higher in sugar compared to their counterparts living in South Asia (Garduno-Diaz & Khokhar, 2012; Gilbert & Khokhar, 2008; Joshi et al., 2007; Radhika et al., 2011).

While there is evidence to indicate that SSB consumption is high among South Asians with consumption frequency comparable to Hispanics and African Americans in this study, further research is needed to assess the determinants and drivers of SSB consumption in this population given the lack of data in this area. Similarly, more research is needed to assess the determinants of ethnic disparities among these various Asian subpopulations as our study also found that Filipinos had significantly higher odds of  $\geq 3$  SSB consumption occasion compared to their Chinese counterparts.

Contrary to research findings where U.S. born were associated with increased consumption of SSB (Ayala, Baquero, & Klinger, 2008; Kudo, Falciglia, & Couch, 2000; Lv & Cason, 2004; Sharkey, Johnson, & Dean, 2011), being born in the U.S. had lower odds of  $\geq 3$  SSB consumption occasion compared to those who were born outside of the U.S. Furthermore, nativity was not independently associated with SSB consumption in any of the Asian subpopulation analyses. Additional research is needed to understand the



complexity in measuring acculturation and assessing the association between acculturation and SSB consumption among this population.

## **LIMITATIONS**

This study has several limitations. First, the SSB consumption occasion is self-reported and may introduce recall or social desirability biases, resulting in potential underreporting and unreliability of the measurement. Second, dietary and beverage questions in the CHIS did not include serving size and therefore, only the frequency of consumption was ascertained in the study. The lack of serving size information also precluded us from converting reported beverage consumption to caloric intake. Future studies are needed to determine the distribution and variation in the types of SSB as a source of calories among Asian subpopulations as this study has demonstrated that great variations exist in the frequency of SSB consumption within these subpopulations. Third, this survey was cross-sectional and cannot assess any causal relationships and only associations were drawn between ethnic disparities and SSB consumption. Lastly, although more than one-third of Asians live in the U.S. reside in California (Census Bureau, 2012), the results from this study among the Asian subpopulations may not be generalizable across the country. However, given the lack of national level data on dietary behaviors among Asians, this study serves as an important first step in ascertaining the eating behaviors in this rapidly growing population.

## **CONCLUSION**

This study found that ethnic differences in SSB consumption continue to exist among non-Hispanic White, Asian, Hispanic and African American adults, with significantly higher odds of SSB consumption occasion among Hispanics and African

Americans. Furthermore, our results clearly demonstrated that these disparities exist among the Asian subpopulations, who are often aggregated as one large “race” category in the analyses of obesity and dietary patterns in large epidemiological studies (Ogden et al., 2013; Ogden et al., 2014). Previous research showed that increased SSB consumption is associated with the displacement of nutrient-dense foods, including lower intakes of macronutrients and can contribute to poorer diets (Britten, Basiotis, Davis, & Anand, 2000; Vartanian et al., 2007). Therefore, identifying the extent and types of SSB consumed by Asians and promoting targeted interventions for these inherently diverse Asian subgroups may be an important effort to effectively promote the reduction of SSB, and may help improve the quality of diet and eating behaviors in these populations. Lastly, this study helped elucidate important information on SSB consumption among Asian adults living in California, but further research is needed to confirm the findings of this study in a nationally representative survey in order for policymakers to develop effective interventions to decrease SSB consumption and to improve healthier eating behaviors among Asians living in the United States.

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**Table 3.1 Characteristics of adults aged 18 and over in the 2009 California Health Interview Survey (CHIS) by ethnicity**

	<i>Total</i>	<i>Non-Hispanic White(ref)</i>	<i>Hispanic</i>	<i>Non-Hispanic Asian</i>	<i>Non-Hispanic Black</i>	<i>Other</i>	
All participants (N)	47,397	31,085	8,222	4,811	1,848	1,431	
Unweighted		66%	17%	10%	4%	3%	
weighted		47%	31%	13%	6%	3%	
Age (years) <sup>1</sup>	45.2 (.04)	49.2 (.13)	40.1 (.19)	43.4 (.38)	46.3 (.69)	43.7 (.59)	**
Sex, Male (%)	49.6(.1)	49.4(.1)	51.4(.2)	47.4(.2)	45.7(.1)	48.1(.1)	**
BMI <sup>2</sup>	26.8 (.05)	26.5 (.07)	28.1 (.12)	23.9 (.13)	27.9 (.29)	27.6 (.25)	**
Education (%)							
<12 years	16.1(.1)	4.5(.2)	36.8(.6)	9.0(1.2)	12.9(1.8)	8.7(1.1)	**
High School							
Graduate/Some College	49.9(.4)	52.1(.5)	50.0(.9)	35.3(1.5)	60.3(2.4)	61.2(3.0)	
Bachelor's Degree	21.7(.3)	27.0(.5)	9.3(.6)	36.3(1.6)	17.3(1.8)	18.2(2.0)	
Master/PhD/							
Professional Degree	12.2(.3)	16.4(.4)	3.9(.3)	19.5(1.1)	9.5(1.4)	11.9(1.7)	
Marital Status (%)							
Married/Living with							
partner	61.2 (.4)	65.4(.5)	59.6(1.1)	61.3(1.5)	40.4(2.3)	51.5(2.8)	**
Divorced/Widowed/							
Separated	14.4(.3)	16.1(.4)	12.6(.7)	8.3(.6)	23.3(1.7)	17.9(1.5)	
Never married	24.3(.4)	18.5(.5)	27.8(.9)	30.3(1.6)	36.2(2.3)	30.5(2.7)	
Poverty (%)							
0-99% FPL <sup>3</sup>	15.8(.4)	6.5(.5)	30.0(1.0)	12.1(1.2)	20.4(2.4)	15.4(2.1)	**
100-199% FPL	17.9(.4)	11.1(.3)	27.2(.8)	17.6(1.3)	21.8(2.1)	18.3(1.8)	
200-299% FPL	13.8(.4)	13(.4)	15.1(.7)	13.2(1.1)	14.9(1.6)	12.8(1.3)	
300% FPL and above	52.5(.4)	69.4(.6)	27.7(1.0)	57.1(1.6)	42.9(2.6)	53.4(2.5)	
Foreign Born (%)	33.0 (.4)	9.0(.4)	57.8(.9)	71.9(1.5)	10.5(1.8)	11.3(2.0)	**
Total SSB <sup>4</sup> consumption							
occasion per week	7.5 (.14)	6.3 (.17)	9.5 (.24)	6.1 (.22)	8.4 (.51)	8.4(.60)	**
Soda	2.1 (.08)	1.8 (.11)	2.8 (.13)	1.3(.09)	2.4 (.23)	2.6 (.26)	**
Coffee or Tea	3.1 (.05)	2.9 (.07)	3.4 (.09)	3.2 (.14)	3.0 (.21)	3.4 (.36)	**
Sports drinks	0.9 (.03)	0.7 (.03)	1.2 (.07)	0.6 (.06)	0.9 (.12)	1.0 (.11)	**
Flavored fruit drinks	1.4 (.05)	0.9 (.06)	2.1 (.09)	1.0 (.06)	2.1 (.22)	1.3 (.18)	**



Fastfood consumption occasion per week	1.5 (.07)	1.4 (.03)	1.7 (.06)	1.3 (.06)	2.0 (.21)	1.6 (.07)	**
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*1 mean  $\pm$  standard error; 2 Body mass index; 3Federal poverty level; 4 Sugar sweetened beverages; \*p-value <0.05; \*\*p-value <0.01*

**Table 3.2 Characteristics of adults aged 18 and over in the 2009 California Health Interview Survey (CHIS) by Asian subgroup**

	Chinese	Japanese	Korean	Filipino	South Asian	Vietnamese	Other Asian	
All self-reported Asians (N=5,062)	1055	427	950	505	411	1413	301	
unweighted %	21%	8%	19%	10%	8%	28%	6%	
weighted %	27%	7%	10%	25%	13%	11%	7%	
Age (years) <sup>1</sup>	44.9(.8)	51.8(1.5)	37.9(1.2)	44.1 (1.03)	38.6 (1.03)	41.6 (1.3)	36.2(1.5)	**
Sex, Male (%)	48.2(2.9)	41.0(3.2)	29.5(5.0)	47.6 (3.4)	59.4 (3.8)	52.0 (5.1)	42.7(5.5)	**
BMI <sup>2</sup>	23.3(.2)	24.7(.4)	22.8(.4)	25.5 (.3)	23.6 (.3)	23.2 (.4)	23.7(.6)	**
Education								
<12 years	13.4(3.1)	3.3(1.5)	5.6(1.1)	6.6 (2.5)	2.0 (.7)	14.6 (3.3)	9.7(2.6)	**
High School Graduate/Some College	31.6(3.0)	40.8(3.9)	33.6(4.8)	42.6 (3.3)	20.9 (3.2)	53.6 (5.8)	41.0(5.6)	
Bachelor's Degree	33.5(3.2)	33.9(3.6)	46.8(5.4)	41.4 (3.7)	27.7 (4.0)	27.0 (4.0)	35.4(5.9)	
Master/PhD/ Professional Degree	21.5(2.6)	22.0(3.3)	14.0(2.7)	9.4 (2.0)	49.4 (4.0)	4.8 (1.3)	13.9(3.2)	
Marital Status								
Married/Living with partner	63.1(3.6)	61.5(3.7)	52.1(5.7)	60.4 (3.7)	64.6 (4.8)	62.3 (5.9)	46.4(4.7)	*
Divorced/Widowed/ Separated	9.0(1.5)	16.3(2.4)	6.3(1.5)	9.1 (1.6)	4.2 (1.1)	5.4 (1.9)	8.0(2.8)	
Never married	27.9(3.4)	22.2(3.4)	41.6(5.6)	30.5 (3.5)	31.2 (4.7)	32.3 (6.0)	45.6(5.2)	
Poverty								
0-99% FPL <sup>3</sup>	13.4(1.9)	6.1(1.5)	14.5(3.6)	9.2 (2.7)	5.1 (1.7)	21.1 (3.1)	27.6(5.1)	**
100-199% FPL	18.3(3.1)	8.3(1.9)	15.7(3.8)	19.8 (2.5)	7.1 (1.6)	28.1 (4.8)	15.5(3.7)	
200-299% FPL	10.0(1.4)	14.4(2.8)	11.6(2.5)	15.4 (2.2)	9.0 (1.9)	19.0 (7.1)	14.4(3.2)	
300% FPL and above	58.3(3.1)	71.2(3.1)	58.2(5.0)	55.6 (3.4)	78.8 (2.8)	31.7 (5.0)	42.6(5.3)	
Foreign Born	76.7(3.1)	21.3(2.7)	62.8(6.0)	65.1 (3.4)	84.6 (4.2)	78.3 (6.1)	62.1(4.8)	**
Fastfood consumption occasion per week	1.0 (.09)	1.2(.10)	1.2 (.10)	1.8(.15)	1.3 (.17)	1.5(.22)	1.4(.20)	**
Total SSB <sup>4</sup> consumption occasion per week	4.4(.24)	6.1(.86)	5.9(.82)	7.4 (.58)	7.9 (.66)	6.4 (.70)	5.8(.52)	**
Soda	0.7(.08)	1.4 (.35)	1.0 (.17)	1.9 (.25)	1.4 (.27)	1.5 (.30)	1.5(.19)	**
Coffee/Tea	2.6(.23)	2.9 (.48)	3.5 (.62)	3.3 (.28)	4.7 (.41)	3.4 (.67)	2.2(.24)	**
Fruit drinks	0.8 (.08)	0.8(.15)	1.1 (.22)	1.3 (.14)	0.9 (.23)	1.1 (.28)	1.2(.24)	*
Flavored fruit drinks	0.3(.05)	0.9 (.16)	0.3 (.04)	0.9 (.19)	0.8 (.23)	0.5 (.09)	0.9(.19)	**

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*1 mean  $\pm$  standard error; 2 Body mass index; 3 Federal poverty level; 4 Sugar sweetened beverages*

*\*p-value <0.05; \*\*p-value <0.01*

**Table 3.3 Adjusted odds ratios of adults reporting >0 and ≥3 consumption occasion of sugar-sweetened beverages per week in the 2009 CHIS<sup>1</sup>**

	Total sugar sweetened beverage >0		Total sugar sweetened beverage ≥3		Soda >0		Soda ≥3		Coffee/Tea >0		Coffee/Tea ≥3		Flavored Fruit/Sports Drinks >0		Flavored Fruit/Sports Drinks ≥3	
	OR <sup>2</sup>	CI <sup>3</sup>	OR	CI	OR	CI	OR	CI	OR	CI	OR	CI	OR	CI	OR	CI
N=47,397																
Race/Ethnicity (NH Whites=ref <sup>4</sup> )																
Hispanics	2.2	[1.9-2.6] **	1.6	[1.4-1.8] **	1.7	[1.5-2.0] **	1.2	[1.0-1.5] *	1.4	[1.3-1.6] **	1.1	[1.0-1.2]	2.1	[1.8-2.4] **	1.8	[1.6-2.1] **
Non-Hispanic Asians	1.2	[0.9-1.4]	1.3	[1.1-1.5] *	1.1	[0.9-1.3]	0.8	[0.6-1.0] *	1.4	[1.2-1.6] **	1.0	[0.9-1.2]	1.1	[0.8-1.3]	1.1	[0.9-1.4]
Non-Hispanic Blacks	2.9	[2.3-3.6] **	1.8	[1.4-2.3] **	1.9	[1.6-2.5] **	1.1	[0.7-1.4]	1.7	[1.3-2.1] **	1.3	[1.0-1.6] *	2.0	[1.6-2.4] **	2.1	[1.5-2.6] **
Others	1.9	[1.4-2.6] **	1.2	[0.9-1.6]	1.5	[1.2-1.9] **	1.3	[1.0-1.8]	1.4	[1.1-1.7] *	1.1	[0.9-1.4]	1.3	[1.0-1.7] *	1.5	[1.1-2.0] *
Gender (women=ref)																
Men	1.7	[1.6-1.9] **	1.6	[1.5-1.8] **	1.7	[1.6-1.9] **	2.0	[1.7-2.3] **	1.1	[0.9-1.2]	1.1	[1.0-1.2]	1.6	[1.5-1.7] **	1.6	[1.4-1.8] **
Age (60 years and older=ref)																
18-39	4.6	[4.2-5.6] **	2.5	[2.2-2.9] **	3.1	[4.2-5.6] **	2.8	[2.4-3.5] **	2.5	[2.2-2.8] **	1.3	[1.1-1.5] *	3.1	[2.7-3.6] **	2.3	[2.0-2.7] **
40-59	1.7	[1.6-1.9] *	1.4	[1.3-1.6] **	1.6	[1.7-1.9] **	1.6	[1.3-2.0] **	1.6	[1.4-1.8] **	1.2	[1.1-1.3] **	1.7	[1.5-1.9] **	1.4	[1.2-1.6] **
Education (Master's degree or higher=ref)																
<12 years	1.3	[0.9-1.8]	1.7	[1.4-2.1] **	1.5	[1.2-1.6] **	1.5	[2.1-4.0] **	1.1	[0.9-1.3]	1.6	[1.3-2.0] **	1.2	[1.0-1.3] *	2.1	[1.6-2.6] **
High School Graduate/Some College	1.3	[1.1-1.4] **	1.7	[1.5-2.1] **	1.4	[1.1-1.5] **	2.9	[2.0-3.4] **	1.1	[1.0-1.3]	1.3	[1.1-1.6] **	1.3	[1.2-1.5] **	2.2	[1.8-2.6] **
Bachelor's degree	1.1	[0.9-1.7]	1.2	[1.1-1.4] *	1.1	[0.9-1.3]	1.6	[1.2-2.2] *	1.0	[0.9-1.3]	1.3	[1.1-1.5] *	1.2	[1.0-1.5] *	1.5	[1.3-1.8] **
Poverty (≥300% FPL <sup>5</sup> =ref)																
0-99% FPL	1.7	[1.4-2.0] **	1.5	[1.3-1.9] **	1.4	[1.1-1.6] **	1.4	[1.1-1.7] *	1.1	[0.9-1.3]	1.1	[1.0-1.3]	1.3	[1.1-1.6] **	1.5	[1.2-1.9] **
100-199% FPL	1.2	[1.0-1.5] *	1.3	[1.2-1.6] **	1.3	[1.1-1.5] *	1.4	[1.2-1.7] **	1.2	[1.0-1.3] *	1.1	[1.0-1.3]	1.2	[1.0-1.4] *	1.3	[1.1-1.5] *
200-299% FPL	1.3	[1.1-1.5] **	1.2	[1.1-1.4] *	1.2	[1.1-1.3] *	1.1	[0.9-1.4]	1.1	[0.9-1.3]	1.1	[0.9-1.3]	1.2	[1.0-1.3] *	1.1	[0.9-1.3]
Physical Activity <sup>6</sup> (Regular=ref)																
Some	1.1	[1.0-1.3] *	1.0	[0.9-1.2]	1.4	[1.3-1.6] **	1.3	[1.1-1.5] *	1.1	[1.0-1.2]	1.1	[0.9-1.2]	1.0	[0.9-1.1]	0.9	[0.8-1.0]
Sedentary	1.1	[0.9-1.2]	1.0	[0.9-1.2]	1.5	[1.3-1.7] **	1.5	[1.3-1.7] **	1.0	[0.9-1.2]	1.0	[0.9-1.2]	0.8	[0.7-0.9] **	0.7	[0.5-0.8] *
Birthplace (Foreign born=ref)																
U.S. Born	0.9	[0.8-1.0]	0.9	[0.8-1.0] *	0.9	[0.8-1.0]	1.0	[0.9-1.2]	0.7	[0.6-0.8] **	0.7	[0.6-0.8] **	0.9	[0.7-1.0] *	1.0	[0.9-1.2]

<sup>1</sup> California Health Interview Survey; <sup>2</sup> Odds Ratio; <sup>3</sup> Confidence Interval; <sup>4</sup> reference group; <sup>5</sup> Federal Poverty Level; <sup>6</sup> regular activity refers to at least 5 days of moderate activity for 30 minutes per day or at least 3 days of vigorous activity for 25 minutes per day. Multivariate logistic regression was used to adjust for sex, race, education marital status, FPL, vegetable and fruit intake, fastfood consumption, physical activity, self-reported diabetes status, and place of birth.

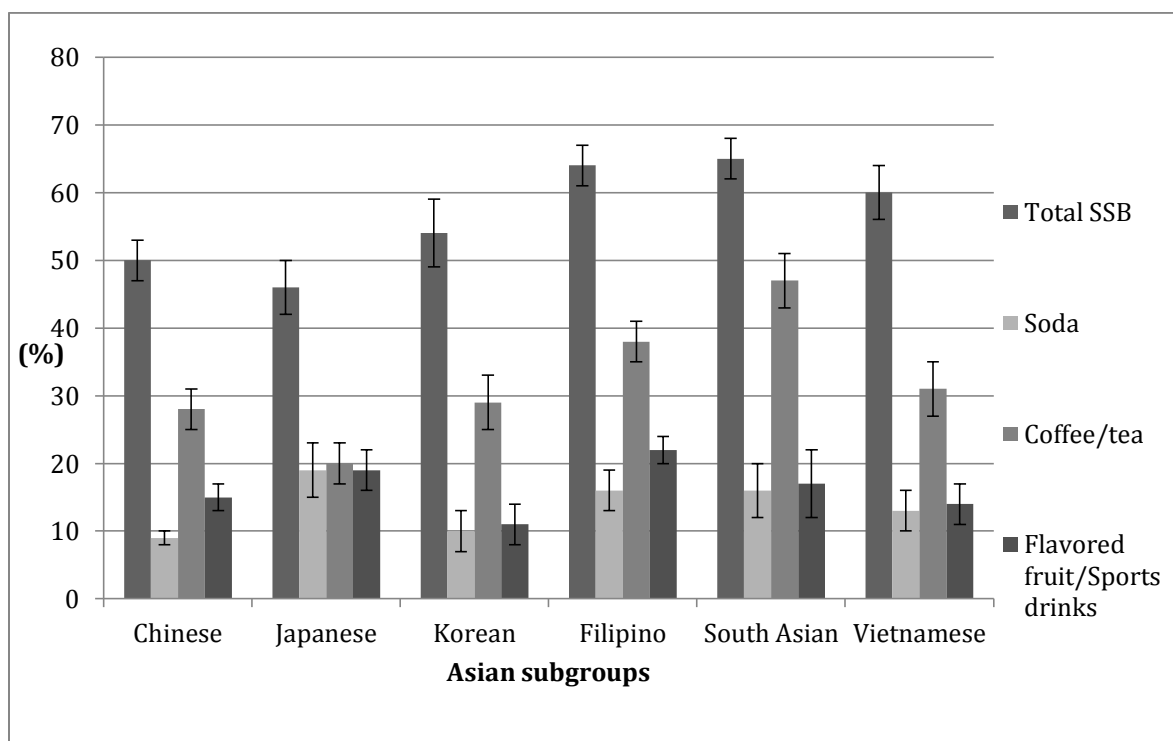
\*p-value <0.05; \*\*p-value <0.01

**Table 3.4 Adjusted odds ratios of adults of Asian descent reporting >0 and ≥3 consumption occasion of sugar-sweetened beverages per week in the 2009 CHIS<sup>1</sup>**

	Total sugar sweetened beverage >0		Total sugar sweetened beverage >3		Soda >0		Soda ≥3		Coffee/Tea >0		Coffee/Tea ≥3		Flavored Fruit/Sports drinks >0		Flavored Fruit/Sports drinks ≥3	
	OR <sup>2</sup>	CI <sup>3</sup>	OR	CI	OR	CI	OR	CI	OR	CI	OR	CI	OR	CI	OR	CI
N=5,062																
<i>Asian Subgroups(Chinese=ref<sup>4</sup>)</i>																
Japanese	1.0	[0.7-1.5]	0.8	[0.5-1.2]	1.4	[0.9-2.0]	3.6	[1.7-7.5] **	0.7	[0.5-1.0]	0.6	[0.4-1.0]	1.1	[0.8-1.6]	1.4	[0.7-2.5]
Korean	2.5	[1.6-3.9] **	1.2	[0.7-1.9]	1.4	[0.8-2.4]	1.5	[0.6-4.0]	1.8	[1.1-2.9] **	1.1	[0.6-1.8]	1.4	[0.7-2.8]	0.7	[0.3-1.6]
Filipino	2.1	[1.3-3.2] **	1.9	[1.3-2.8] **	2.8	[1.9-4.2] **	2.8	[1.4-5.7] **	1.5	[1.0-2.1] *	1.6	[1.1-2.4] *	1.7	[1.2-2.5] **	1.7	[1.0-2.8] *
South Asian	1.1	[0.7-1.8]	2.0	[1.3-2.9] **	1.0	[0.6-1.8]	2.7	[1.1-6.8] *	1.4	[0.9-2.3]	2.4	[1.5-3.9] **	0.8	[0.5-1.2]	1.1	[0.5-2.5]
Vietnamese	2.2	[1.3-3.7] *	1.6	[1.0-2.4] *	1.8	[1.2-2.7] *	2.1	[0.9-4.7]	0.8	[0.5-1.5]	1.2	[0.7-1.9]	1.5	[1.0-2.4]	0.9	[0.5-1.7]
Other Asian	1.2	[0.7-2.2]	0.6	[0.3-1.2]	2.1	[1.2-3.4] *	1.6	[0.6-4.3]	0.7	[0.4-1.4]	1.1	[0.6-2.2]	2.2	[1.3-3.8] **	0.9	[0.4-2.0]
<i>Gender (women=ref)</i>																
Men	1.2	[0.9-1.7]	1.4	[1.1-1.8] *	1.7	[1.3-2.3] **	1.9	[1.1-3.1] *	1.2	[0.9-1.6]	1.0	[0.8-1.4]	1.3	[1.0-1.7]	1.6	[1.1-2.4] *
<i>Age (60 years and older=ref)</i>																
18-39	3.6	[2.3-5.7] **	1.8	[1.2-2.7] *	4.5	[3.1-6.5] **	3.4	[2.8-4.0] **	2.3	[1.6-3.4] **	0.8	[0.7-1.3]	3.9	[2.6-5.8] **	3.1	[1.7-5.6] *
40-59	1.3	[0.9-1.9]	1.1	[0.8-1.4]	1.8	[1.2-2.5] **	1.9	[1.6-2.3] **	1.3	[0.9-1.7]	0.9	[0.6-1.2]	1.5	[1.1-2.2] *	1.7	[1.0-2.9]
<i>Education (Master's degree or higher=ref)</i>																
<12 years	0.5	[0.2-0.9] *	0.9	[0.5-1.8]	0.7	[0.4-1.2]	2.5	[0.9-7.0]	0.5	[0.3-1.1]	0.7	[0.3-1.3]	0.5	[0.3-1.0] *	1.4	[0.6-3.2]
High School Graduate/Some College	1.4	[0.9-2.2]	1.6	[1.0-2.5] *	1.6	[1.1-2.4] *	2.0	[1.0-3.9]	1.0	[0.7-1.4]	1.0	[0.6-1.6]	1.2	[0.8-1.9]	2.8	[1.6-4.9] *
Bachelor's degree	1.4	[0.9-2.1]	1.3	[0.9-1.9]	1.6	[1.1-2.3] *	2.0	[1.0-4.0]	0.9	[0.7-1.3]	1.0	[0.7-1.5]	1.1	[0.8-1.7]	2.4	[1.5-4.2] *
<i>Poverty (≥300% FPL<sup>5</sup>=ref)</i>																
0-99% FPL	0.8	[0.4-1.5]	1.1	[0.7-1.7]	0.8	[0.5-1.3]	0.7	[0.4-1.4]	1.3	[0.8-2.0]	1.5	[0.9-2.1]	0.8	[0.7-1.5]	1.0	[0.4-2.1]
100-199% FPL	1.0	[0.5-1.8]	1.0	[0.7-1.5]	1.0	[0.6-1.4]	0.8	[0.4-1.6]	1.3	[0.8-1.9]	0.9	[0.6-1.3]	1.0	[0.7-1.4]	1.0	[0.6-1.7]
200-299% FPL	1.4	[0.9-2.1]	1.0	[0.6-1.6]	1.3	[0.9-2.0]	1.1	[0.6-1.9]	1.3	[0.8-2.0]	1.2	[0.8-1.9]	1.0	[0.7-1.5]	0.9	[0.6-1.5]
<i>Physical Activity<sup>6</sup> (Regular=ref)</i>																
Some	0.9	[0.6-1.2]	0.8	[0.6-1.1]	1.5	[1.1-2.1] **	1.0	[0.5-1.9]	1.1	[0.8-1.5]	0.7	[0.5-1.0] *	0.9	[0.6-1.3]	0.7	[0.4-1.1]
Sedentary	0.8	[0.6-1.2]	0.8	[0.6-1.1]	1.9	[1.3-2.8] **	1.2	[0.6-2.1]	1.1	[0.8-1.6]	0.8	[0.5-1.2]	0.7	[0.5-0.9] *	0.6	[0.3-1.0] *
<i>Birthplace (Foreign born=ref)</i>																
U.S. Born	1.1	[0.6-1.8]	1.1	[0.8-1.5]	0.8	[0.6-1.0]	0.6	[0.3-1.0]	0.9	[0.6-1.3]	1.2	[0.8-1.6]	0.9	[0.6-1.2]	1.1	[0.7-2.0]

<sup>1</sup> California Health Interview Survey; <sup>2</sup> =Odds Ratio; <sup>3</sup> =Confidence Intervals; <sup>4</sup> =reference group; <sup>5</sup> =Federal Poverty Level; <sup>6</sup> = regular activity refers to at least 5 days of moderate activity for 30 minutes per day or at least 3 days of vigorous activity for 25 minutes per day. Multivariate logistic regression was used to adjust for sex, race, education marital status, FPL, vegetable and fruit intake, fastfood consumption, physical activity, self-reported diabetes status, and place of birth

\*p-value <0.05; \*\*p-value <0.01



<sup>1</sup>All values are means  $\pm$  standard errors (SEs) of the predicted marginals based on multivariate logistic regressions adjusted for sex, race, education, marital status, federal poverty level, vegetable and fruit intake, fast-food consumption, physical activity, self-reported diabetes status, and place of birth.

**Figure 3.1: Adjusted percentages of Asian adults reporting  $\geq 3$  consumption occasion of SSB per week by types of beverage in the 2009 California Health Interview Survey<sup>1</sup>**

### Annex 3.1 Percentages of Individuals with no beverage consumption in the past 7 days, by race/ethnicity and type of beverage<sup>1</sup>

	<i>Total</i>	<i>Non-Hispanic White(ref)</i>	<i>Hispanic</i>	<i>Non-Hispanic Asian</i>	<i>Non-Hispanic Black</i>	<i>Other</i>	
Population (N)	47,397	31,085	8,222	4,811	1,848	1,431	
unweighted		66%	17%	10%	4%	3%	
weighted		47%	31%	13%	6%	3%	
No SSB <sup>2</sup> consumption in the last 7 days (%)	17.8(.3)	24.8(.4)	9.0(.4)	18.3 (1.3)	10.6 (1.1)	14.5(1.9)	**
<i>Soda</i>	46.1(.4)	55.0 (.6)	33.5 (.9)	50.4(1.6)	36.1 (2.3)	43.7 (2.8)	**
<i>Coffee or Tea</i>	45.9(.5)	54.5 (.5)	36.8 (1.0)	39.7 (1.8)	41.2(2.6)	46.2 (2.7)	**
<i>Sports drinks</i>	68.8 (.5)	72.6 (.6)	61.7 (.8)	73.5 (1.7)	68.4(2.3)	66.2 (2.4)	**
<i>Fruit drinks</i>	55.7 (.5)	67.4 (.6)	40.1(1.1)	56.3 (1.7)	44.2 (2.2)	60.7 (2.7)	**

<sup>1</sup>percentage  $\pm$  standard error; <sup>2</sup>Sugar sweetened beverages

\*p-value <0.05; \*\*p-value <0.01

### Annex 3.2 Percentages of Individuals with no beverage consumption in the past 7 days, by Asian sub-groups and type of beverage<sup>1</sup>

	Chinese	Japanese	Korean	Filipino	South Asian	Vietnamese	Other Asian	
Total sample population (N=5,062)	1055	427	950	505	411	1413	301	
unweighted %	21%	8%	19%	10%	8%	28%	6%	
weighted %	27%	7%	10%	25%	13%	11%	7%	
No SSB2 consumption in the past week (%)	25.4(3.2)	22.9(2.7)	10.5(1.5)	14.4(2.7)	17.5 (3.7)	11.8 (2.4)	17.0(4.2)	**
Soda	61.0(3.5)	60.7 (3.6)	50.1 (6.2)	36.5 (3.4)	52.8 (4.5)	42.7 (3.9)	38.0 (6.5)	**
Coffee/Tea	44.1(3.3)	56.9 (3.4)	29.7 (4.9)	36.1 (3.1)	32.1 (4.5)	42.9 (5.5)	47.6(7.1)	**
Fruit drinks	60.8 (3.1)	66.1 (3.3)	46.8 (5.9)	49.4 (3.8)	60.3 (4.2)	56.6 (4.0)	39.6 (6.3)	*
Sports drinks	80.8 (2.5)	74.8 (3.7)	65.8 (5.8)	71.1 (3.4)	68.9 (4.4)	67.6 (5.4)	70.5 (6.0)	

<sup>1</sup> percentage + standard error; <sup>2</sup> Sugar sweetened beverages

\*p-value <0.05; \*\*p-value <0.01



**Annex 3.3 Adjusted percentages of adults of Asian descent reporting  $\geq 7$  consumption occasion of sugar-sweetened beverages per week in the 2009 California Health Interview Survey, by type of beverage**

	Total sugar sweetened beverage % $\pm$ SE <sup>1</sup>	Soda % $\pm$ SE	Coffee or tea % $\pm$ SE	Flavored or sports drinks % $\pm$ SE
Asian sub-groups (N=5062)				
Chinese (ref <sup>2</sup> )	31 $\pm$ 3	3 $\pm$ 1	19 $\pm$ 3	5 $\pm$ 1
Japanese	33 $\pm$ 4	14 $\pm$ 4*	18 $\pm$ 3	13 $\pm$ 2*
Korean	32 $\pm$ 4	5 $\pm$ 2	25 $\pm$ 4	8 $\pm$ 2
Filipino	44 $\pm$ 3*	10 $\pm$ 2*	27 $\pm$ 3*	12 $\pm$ 2*
South Asian	57 $\pm$ 4*	10 $\pm$ 3*	40 $\pm$ 4*	7 $\pm$ 2
Vietnamese	35 $\pm$ 5	5 $\pm$ 2	29 $\pm$ 5*	5 $\pm$ 2
Southeast Asian	36 $\pm$ 7	8 $\pm$ 3	16 $\pm$ 4	14 $\pm$ 5*
Other Asian	33 $\pm$ 6	6 $\pm$ 3	23 $\pm$ 6	5 $\pm$ 3
Gender				
Women(ref)	35 $\pm$ 2	5 $\pm$ 1	24 $\pm$ 2	7 $\pm$ 1
Men	42 $\pm$ 2*	8 $\pm$ 1*	27 $\pm$ 2	9 $\pm$ 1
Age (years)				
18-39	39 $\pm$ 2*	21 $\pm$ 1*	22 $\pm$ 1*	10 $\pm$ 1
40-59	37 $\pm$ 2*	7 $\pm$ 1*	27 $\pm$ 1	6 $\pm$ 1
60 and older(ref)	40 $\pm$ 3	9 $\pm$ 1	25 $\pm$ 1	5 $\pm$ 1*
Education				
<12 years	37 $\pm$ 6*	11 $\pm$ 4*	22 $\pm$ 4	4 $\pm$ 1
High School Graduate/Some College	43 $\pm$ 3*	9 $\pm$ 0	28 $\pm$ 2	10 $\pm$ 1*
Bachelor's degree	36 $\pm$ 2*	6 $\pm$ 1	24 $\pm$ 2	8 $\pm$ 1*
Master's or Higher (ref)	34 $\pm$ 4	4 $\pm$ 1	24 $\pm$ 4	3 $\pm$ 1
Poverty				
0-99% FPL	39 $\pm$ 5*	6 $\pm$ 2	29 $\pm$ 1	13 $\pm$ 4*
100-199% FPL	37 $\pm$ 4*	7 $\pm$ 2	23 $\pm$ 3	12 $\pm$ 2*
200-299% FPL	44 $\pm$ 4*	9 $\pm$ 2	29 $\pm$ 3	9 $\pm$ 2*
300% FPL and above(ref)	38 $\pm$ 2	6 $\pm$ 1	24 $\pm$ 2	5 $\pm$ 1
Diabetes status				
No	41 $\pm$ 1*	7 $\pm$ 1*	27 $\pm$ 1*	9 $\pm$ 1*
Borderline/Pre-diabetic	16 $\pm$ 5	4 $\pm$ 2	11 $\pm$ 4*	3 $\pm$ 0
Yes(ref)	20 $\pm$ 1	3 $\pm$ 1	10 $\pm$ 2	3 $\pm$ 1
Birthplace				
U.S. Born	38 $\pm$ 2	5 $\pm$ 1*	24 $\pm$ 2	9 $\pm$ 1
Foreign Born(ref)	40 $\pm$ 3	8 $\pm$ 1	26 $\pm$ 2	8 $\pm$ 1

*1*Percentages  $\pm$  Standard errors (SE); *2* reference group. Predicted marginals were based on multivariate logistic regression adjusted for sex, race, education, marital status, federal poverty level (FPL), vegetables and fruits intake, fast-food consumption, physical activity, diabetes status, and place of birth. SE <0.05 is listed as 0; \*p-value <0.05

## **CHAPTER 4: THE ASSOCIATIONS OF ACCULTURATION DIMENSIONS AND SUGAR-SWEETENED BEVERAGE CONSUMPTION AMONG ASIAN ADULTS LIVING IN CALIFORNIA**

### **ABSTRACT**

**Background:** Dietary intake, including sugar-sweetened beverage consumption, is an important determinant of obesity in the U.S. Previous studies demonstrated that acculturation is associated with increased risk for obesity, but its association with dietary intake remains unclear among Asians living in the United States.

**Objectives:** To examine different dimensions of acculturation and their differential associations with SSB consumption among Asian American adults in California.

**Methods:** This study is a cross-sectional analysis of 5,062 self-reported Asians who participated in the 2009 California Health Interview Survey. Factor analysis was performed to assess the various dimensions of acculturation. Asian subgroups were stratified and regression analyses were conducted to assess the differential associations of acculturation with SSBs consumption.

**Results:** Three dimensions were identified: 1) age of arrival to the U.S., 2) time exposure to the U.S., and 3) language use/media preference. This study found that acculturation was associated with increased sugar-sweetened beverages consumption, including soda and flavored/sports drinks among Asian adults. Increased acculturation, as measured by the age of arrival to the U.S., was most strongly associated with the increased odds of soda intake. In contrast, time exposure to the U.S. and language use/media preference were not consistently associated with higher SSB consumption.

**Conclusion:** Our results indicate that acculturation is independently associated with SSB consumption among Asian adults, with the acculturation dimension “age of arrival to the U.S.” having the strongest association. This finding may imply that physical exposure to U.S. culture at earlier stages of life plays an important role in Asian American adults’ overall beverage consumption patterns. Policymakers should consider designing public health interventions that specifically target Asian children and youth from excess SSB consumption as an important primary prevention measure.

## INTRODUCTION

The consumption of added sugars and sugar-sweetened beverages (SSB) in the U.S. has increased dramatically, and its temporal patterns parallel the rise in obesity (Bleich, Wang, Wang, & Gortmaker, 2009; Malik, Popkin, Bray, Despres, & Hu, 2010). Between 1977 and 2001, the percent of calories from all beverages in the U.S. increased by more than 50% while the prevalence of obesity among U.S. adults doubled (Duffey & Popkin, 2007; Flegal, Carroll, Ogden, & Johnson, 2002). While recent data suggest that the absolute intake of added sugar has decreased between 1999-2008, sugar consumed from SSB continues to be one of the largest contributors of caloric intake in the U.S. and evidence overwhelmingly supports a positive association between SSB consumption and the risk of obesity (Hu & Malik, 2010; Hu, 2013; Malik, Schulze, & Hu, 2006; Malik, Popkin, Bray, Despres, & Hu, 2010; Malik, Pan, Willett, & Hu, 2013; Mozaffarian, Hao, Rimm, Willett, & Hu, 2011; Schulze et al., 2004; Vartanian, Schwartz, & Brownell, 2007; Welsh, Sharma, Grellinger, & Vos, 2011). Data from national surveys demonstrated that one-third of calories from added sugars (33%) came from beverages, and regular sodas continues to be the leading food source of added sugars for adults aged 18–54 living in the U.S. (Ervin & Ogden, 2013; Kit, Fakhouri, Park, Nielsen, & Ogden, 2013; Ogden, Kit, Carroll, & Park, 2011; Welsh et al., 2011). Aside from contributing to the obesity epidemic in the U.S., the consumption of SSB has also been associated with an increased risk of chronic diseases such as type II diabetes and coronary heart disease (de Koning et al., 2012; Hu & Malik, 2010; Malik et al., 2010; Malik et al., 2013).

During this same period, the U.S. had seen a dramatic increase of immigrant populations from Asian countries, and Asians are now the fastest growing ethnic group

in the U.S. with a total population of 17 million (Census Bureau, 2012). As a consequence of this shift in demographics in the U.S., the influence of acculturation, defined as “the process by which individuals adopt the attitudes, values, customs, beliefs, and behaviors of another culture”(Clark, 1998) on the risk of obesity, chronic diseases, and other health outcomes, has generated much research interests in recent years.

Prior studies examining the association between obesity and acculturation among immigrants consistently demonstrated an increased body mass index (BMI) with higher levels of acculturation, regardless of how acculturation was measured (Barcenas et al., 2007; Goel, McCarthy, Phillips, & Wee, 2004; Kaplan, Huguet, Newsom, & McFarland, 2004; Novotny, Williams, Vinoya, Oshiro, & Vogt, 2009; Roshania, Narayan, & Oza-Frank, 2008; Sanchez-Vaznaugh, Kawachi, Subramanian, Sanchez, & Acevedo-Garcia, 2008; Wolin, Colangelo, Chiu, & Gapstur, 2009). Studies focusing on Asian Americans have also confirmed this positive association between BMI and acculturation (Chen, Juon, & Lee, 2012; Maskarinec et al., 2006; Novotny et al., 2009; Novotny et al., 2012; Sanchez-Vaznaugh et al., 2008). Moreover, a small number of studies have demonstrated the association of acculturation with increased chronic disease risks including diabetes, hypertension and other cardiovascular diseases among Asian Americans (Kandula et al., 2008; Raj, Ganganna, & Bowering, 1999; Teppala, Shankar, & Ducatman, 2010; Ueshima et al., 2003; Venkatesh, Weatherspoon, Kaplowitz, & Song, 2013; Yang, Chung, Kim, Bianchi, & Song, 2007).

The association of acculturation on dietary intake and diet quality among Asian Americans, however, has been less clear. Studies found that more acculturated Asians had higher consumption of fats (Pan, Dixon, Himburg, & Huffman, 1999; Park, Murphy,

Sharma, & Kolonel, 2005; Satia et al., 2001), carbohydrates (Pan et al., 1999), and overall energy intake (Liu, Berhane, & Tseng, 2010; Lv & Cason, 2004), but they also demonstrated an increase in consumption including whole grains (Park et al., 2005), fruits and vegetables among this group (Pan et al., 1999; Satia et al., 2001). Fewer studies have specifically examined the association between acculturation and SSB consumption among Asians and their findings have also been mixed. Some have found a positive relationship between fries and soda consumption (Wang, Quan, Kanaya, & Fernandez, 2011), coffee and soda consumption (Lv & Cason, 2004), and “sweetened drinks”(Novotny et al., 2012) with increased acculturation, while others have found negative or insignificant association between SSB and acculturation (Park et al., 2005; Song et al., 2004) .

The inconsistent findings in these studies may be the result of how acculturation was measured (i.e. using nativity and language only) (Wang et al., 2011), or including educational level in the total acculturation score (Novotny et al., 2012), when assessing its association with beverage consumption. It could also be due to differences in study design, study populations, and how SSB was defined. Furthermore, most of these studies were conducted in only one or two Asian subgroups and the comparison of SSB consumption across different Asian populations has not been studied.

A review of the acculturation measurements used in health research of Asian immigrant populations found that the physical health outcomes are differentially associated by separate measurements of acculturation dimensions, and that disease risks among Asian immigrants were differentially predicted depending on the dimension of acculturation used in the study (Salant & Lauderdale, 2003). Therefore, it is imperative

that different dimensions of acculturation are included in this study so that the association of acculturation and behaviors can be clearly delineated.

Given the varying findings when assessing the association between acculturation and SSB consumption and the lack of consensus on how acculturation should be measured in the Asian American population, this study aims to use the adult component of the 2009 California Health Interview Survey (CHIS) to:

1. Examine the relationship between acculturation and SSB consumption among subpopulations of Asian American adults; and
2. Determine whether differential associations of SSB consumption and acculturation exist among Asian American adults when different dimensions of acculturation are ascertained.

There were two hypotheses for this study: 1) a significant increase in SSB consumption with increased level of acculturation; and 2) variations in the strength of association between SSB consumption and acculturation when different dimensions of acculturation are measured.

## **METHODS**

### *Study design and sample*

For this study, data from the 2009 California Health Interview Survey (CHIS) Adult component were used. The 2009 CHIS is a population-based survey and is the largest health survey ever conducted in any state. For the 2009 CHIS, it surveyed 47,614 adults, including 5,125 self-reported Asians, using a two-stage geographically stratified random digit dial (RDD) sample design. It is able to produce statewide estimates for California's overall population, including its major racial and ethnic groups, including a



selection of Asian and Latino ethnic subgroups. A complete description of data collection procedures and analytic guidelines are found elsewhere. (<http://www.askchis.com/designs-methods.html>)

This study sample consists of all non-institutionalized self-reported Asian adults aged  $\geq 18$  years old residing in California at the time of the interview, conducted between September 2009 and April 2010. Survey respondents were excluded if they were pregnant at the time of data collection. A final sample of 5,062 adults was used in the analyses.

## **Measures**

### *Dependent variable: Sugar-sweetened beverages (SSB)*

For sugar-sweetened beverages, this study included carbonated soft drinks, sugar-sweetened coffee and tea, and noncarbonated SSB such as fruit punches, lemonade, energy drinks and sports drinks such as Gatorade<sup>®</sup>. Survey respondents reported on how often they consumed the following four types of SSB: 1) soda, 2) flavored fruit drinks, 3) sports drinks, and 4) coffee/tea. Respondents had the option of answering by either the number of times per day, per week, or per month, but all of the responses were converted to number of times per week for the analyses.

Outcome responses for the total consumption of SSB were categorized by the amount of sweetened beverages they consumed into none in the past seven days vs. any consumption over the past seven days. The consumption frequencies of noncarbonated SSB such as sports and energy drinks (i.e. Gatorade) and flavored fruit punches were combined into “flavored/sports drinks” consumption frequency in this analysis due to the

overall low consumption rates of these beverages among Asians. Diet beverages and unsweetened coffee/tea were not included in these analyses.

*Independent variables:*

*Race, ethnicity*

All individuals who were self-reported as one of the Asian subgroups, including those who have also reported to be Hispanic Asian, were included in the analysis. These groups are categorized into: Chinese, Japanese, Korean, South Asian, Filipino, Vietnamese, and Other Asian (Pacific Islanders and self-reported Asians with more than 2 races).

*Acculturation*

Acculturation was measured using 10 self-reported items available in the 2009 CHIS. These items included questions on place of birth of the respondent, places of birth of the respondent's parents, years of residence in the U.S., percent of life living in the U.S., age at the time of immigration, and four scale-based items assessing language, media preference and proficiency.

Percent of life living in the U.S. was categorized into <20%, 21-40%, 41-80%, and >80%, while age at the time of immigration was categorized into <18 years old vs.  $\geq$ 18 years old. The number of years living in the U.S. was divided into <5 years, 5-<10 years, 10-<15 years, and 15 or more years/U.S. born. Countries of birth for the respondent's mother and father were converted into generational status, where first generation consists of individuals born outside of the U.S., second generation includes those born in the U.S. but parents were born outside of the U.S., and third generation includes those born in the U.S. with at least one parent also being born in the U.S. Factor

Analysis (FA) was used to generate factor scores which were then divided into tertiles to represent low, middle, and high acculturation levels.

#### *Health and healthy behavior*

Physical activity was divided into three categories, low, moderate, and vigorous, based on the number of times per week that the respondent reported engagement in physical activities. Fruit consumption per week was included as a continuous variable in the analysis. General health status was categorized into poor/fair, good, and very good/excellent. Self-reported diabetes status was categorized into diabetes, pre-diabetes/borderline, and no diabetes.

#### *Sociodemographic status*

Age was categorized into 18-39, 40-59, and 60+ years old; marital status was classified into three categories (married/living together, separated/divorced/widowed, and never married). Four educational attainment categories were used: master's degree or higher, college graduate, high school graduates/some college, and less than high school. Four family income levels expressed as a percentage of the federal poverty level (FPL) of  $\geq 300\%$ , 200-299%, 100-199%, and  $\leq 99\%$  were included.

### **Statistical Analysis**

Factor Analysis (FA) was applied on all of the 10 acculturation-related questions to identify the latent traits of acculturation and to group them on the basis of their inter-correlations. This method assessed the number of substantial components (dimensions) that accounted for the variance among the acculturation-related questions. All Asian subgroups were pooled to create common acculturation components to allow for subgroup comparisons. All components with an eigenvalue  $>1$  were considered; parallel

analysis and scree plots were performed to determine the number of components to be included in the final model. Each retained component was orthogonally rotated with a varimax rotation to produce orthogonal factors. Factor score for each retained component was then calculated into a summary measure of acculturation based on the component loading weights. Scores were normally distributed with a mean of zero and a standard deviation of approximately one. A high positive score signifies a high level of acculturation, whereas a low or negative score represents low level of acculturation. Factor scores were divided into tertiles to represent low, middle, and high acculturation levels.

Multivariate logistic regressions were used to investigate the association between the different dimensions of acculturation and SSB consumption. The types of SSB consumed were categorized as dichotomous outcomes among all Asians and in the sub-group analyses. All analyses were conducted on STATA version 11 (Stata Corp, College Station, TX) and weighted to represent the non-institutionalized adult population in California. In order to account for the complex sampling structure, jackknife variance estimation method was used to compute and adjust for the standard error estimates.

Based on weighted regression models, the multivariate-adjusted odds ratios and 95% confidence intervals for each race/ethnicity and the Asian sub-groups were assessed in this study. Tests for interaction between acculturation and gender, acculturation and poverty, and acculturation and education on SSB consumption were performed to assess whether the association of acculturation and SSB consumption varied by these factors.

## **RESULTS**

### **Acculturation characteristics of Asian sub-groups**

**Table 4.1** reports the acculturation characteristics of the study sample among those adults of self-reported Asian descent. Overall, Chinese (27%), Filipino (25%), and South Asian (13%) constituted the largest percentages of Asian in the weighted sample. There were significant differences among these Asian sub-groups with respect to age, education, poverty level, and on all measures related to acculturation. South Asians were significantly more educated (49% with a post-bachelor degree) and 79% were living above the 300% federal poverty level while Vietnamese were the least educated (5% with a post-bachelor degree).

Measures of acculturation were significantly different among Japanese when compared to the rest of the Asian subgroups. More than 78% of Japanese were second or third generation born Asian American, compared to only 37% among the rest of the Asian population. Approximately 84% of Japanese spent more than 80% of their lives living in the U.S, while the next highest sub-group (Other Asian) had only 46% spending more than 80% of their lives in the U.S. Although the majority of Filipino and South Asians were foreign born and most did not spend a majority of their lives in the U.S., their English proficiency and use of English at home and in other settings were higher when compared to other Asian immigrants.

### **Acculturation patterns**

Factor analysis of acculturation identified two major components. The variable “age of arrival to the U.S.” was shared in both components with factor loadings  $>0.5$ . Based on previous literature on “crossloading” variables that are shared across factors, this variable was taken out as its own variable in the regression model and was not included in the factor analysis (Costello & Osborne, 2005; DiStefano, Zhu, & Mindrila,

2009). The two major factors were named “language use/media preference” and “time exposure to U.S.” based on previously identified patterns in the literature in measuring acculturation among Asian immigrant populations (Salant & Lauderdale, 2003). **Table 4.2** demonstrates the loading items for the two components and their factor loading weights. Factor loadings were high for both components, with loadings ranging from 0.71 (generational status) to 0.87 (language proficiency).

#### **Sugar-sweetened beverage consumption by level of acculturation**

**Table 4.3** demonstrates the differences in the unadjusted means of sugar sweetened beverage consumption over the past seven days disaggregated by type of SSB. The mean frequency of SSB consumption was higher for all types of SSB (soda, coffee/tea, flavored drinks and sports drinks) for individuals who were born in the U.S. or had arrived in the U.S. before the age of 18, compared to those who arrived in the U.S. at or after the age of 18. Significant differences in SSB consumption were found in coffee/tea consumption and sports drinks in the time exposure to the U.S. dimension. Individuals with higher levels of acculturation consumed less coffee/tea (low:  $3.8 \pm 0.3$ ; medium:  $3.2 \pm 0.2$ ; high  $2.8 \pm 0.2$ ) but more sports drinks ((low:  $0.4 \pm 0.1$ ; medium:  $0.4 \pm 0.1$ ; high  $1.0 \pm 0.1$ ), compared to those in the lowest tertile. Significant differences were also found in the language/media preference dimension in relation to the three levels of acculturation for soda (low:  $0.5 \pm 0.1$ ; medium:  $1.3 \pm 0.2$ ; high  $1.7 \pm 0.1$ ), coffee/tea (low:  $3.4 \pm 0.5$ ; medium:  $3.6 \pm 0.2$ ; high  $2.8 \pm 0.2$ ), and sports drinks (low:  $0.2 \pm 0.04$ ; medium:  $0.5 \pm 0.2$ ; high  $0.9 \pm 0.1$ ).

#### **Differences in adjusted SSB consumption by acculturation dimensions**

**Table 4.4** demonstrates the association of acculturation and SSB consumption among the seven Asian populations based on the three different dimensions of acculturation. The adjusted odds ratios (ORs) of consuming any SSB in the past seven days varied depending on the acculturation dimension selected in the analysis. The use of age of arrival as the acculturation measurement resulted in the most number of significant findings. The odds of consuming any SSB were 1.8 times higher (95% CI: 1.2-2.7) among all Asians born in the U.S. or having arrived in the U.S. before the age of 18, compared to those who arrived in the U.S. after age 18. Higher odds of SSB consumption were significant for Chinese- and Japanese-origin Asians: OR=2.8 (95% CI: 1.3-6.0) and 2.4 (95% CI: 1.1-4.6), respectively. In regards to time exposure to the U.S., only Chinese in the high acculturation category had significantly higher odds (OR=2.8 [95% CI: 1.2-6.9]) of consuming any SSB compared to their lesser acculturated counterparts. Language use/media preference was not associated with total SSB consumption in any of the Asian subgroups.

Similarly, the odds of consuming any soda were 1.3 (95% CI: 1.0-1.7) times higher among all Asians born in the U.S. or arrived in the U.S. before age 18 and 2.2 (95% CI: 1.2-4.3) times higher among Chinese born in the U.S./arrived in U.S. before 18 when compared to those arrived in the U.S. after age 18. The ORs for any soda consumption was also significantly higher among Asians who had medium and high acculturation by language/media preference when compared to the low acculturation group (OR=1.8 [95% CI: 1.2-2.9], OR=1.8 [95% CI: 1.2-2.8], respectively). Koreans who had medium level of acculturation by language/media preference also had higher odds of soda consumption (OR=2.7 [95% CI: 1.0-7.3]). Interestingly, the odds of any

soda consumption were lower (OR=0.4 [95% CI: 0.2-0.8]) among Filipino born in the U.S/arrived in U.S. before age 18 compared to those arrived after age 18.

The odds of consuming any flavored/sports drinks were 1.3 (95% CI 1.0-1.7) times higher among all Asians born in the U.S/arrived in the US before age 18, but no significant association was found in the stratified analysis among the Asian subgroups. In addition, no association was found in the consumption of coffee/tea with respect to acculturation regardless of which acculturation dimension was used in the overall and sub-group analyses. No effect modification was found in the study.

## **DISCUSSION**

### **Key Findings**

This study found that acculturation was associated with increased sugar-sweetened beverage consumption, including soda and flavored/sports drinks, among a population-based sample of Asian American adults residing in California. Increased acculturation was most strongly associated with the increased odds of soda intake. Asian Americans who were born in the U.S. or had lived in the U.S. before the age of 18 would more frequently drink SSBs than those who came to the U.S. as an adult. In contrast, time exposure to the U.S. and language use/media preference had weaker associations with higher SSB consumption, compared to age of arrival in the U.S. This finding may imply that physical exposure to U.S. culture at earlier stages of life plays an important role in Asian American adults' overall beverage consumption patterns.

Data on the association between acculturation and SSB consumption among Asians have not been consistent, and to our knowledge, no study has compared the differences among all seven Asian subgroups in one single study. This study found



increased odds of any soda consumption among Chinese (OR=2.2) and Korean (OR=2.7) with increased acculturation (by age of arrival and language proficiency/media preference), while a negative relationship was found among Filipinos (OR=0.4). These differing results highlight the variations that exist among Asian American subpopulations. However, for the combined flavored/sports drink consumption, the study demonstrated increased odds of intake with increased acculturation in the total Asian sample, but no significant association in the subgroup analysis.

### **Acculturation measurement**

Difficulties in measuring acculturation among Asian Americans are complicated by the vastly different experiences encountered among these immigrant subgroups. In addition, the extent to which acculturation measurements used among Hispanics can be applied to Asians is questionable (Salant & Lauderdale, 2003). This study used factor analysis to delineate the various underlying constructs of acculturation in an effort to disentangle how different dimensions of acculturation relate to SSB consumption—an important measure of dietary behavior.

Similar to results found in a systematic review of the relationship between different acculturation measurements and diet among Latinos, the observed relationships in this study among Asians depended on the measure of acculturation (Ayala, Baquero, & Klinger, 2008). Among three acculturation constructs used in this study, age at immigration was the most sensitive measure in delineating the relationship between acculturation and SSB consumption. While language use/media preference is used widely among researchers to measure acculturation (Ayala et al., 2008; Salant & Lauderdale, 2003; Satia-Abouta, Patterson, Neuhouser, & Elder, 2002), English is the

*lingua franca* among many South Asians and Filipinos in their countries of origin and can be a poor measure of acculturation and the level of integration into the U.S. society—as demonstrated in this study. Furthermore, the use of western media exposure can be problematic in an age of increasing globalization and the use of online social media, where U.S. media productions/articles are readily available over the internet, regardless of where an individual resides.

Similarly, although time exposure to the U.S. is a good temporal index, its direct relationship to the process of acculturation can be vastly different depending on whether an immigrant arrived in the U.S. as a child or adult (Baker, 2011; Chakraborty & Chakraborty, 2010). This is supported by the findings from this study. Among the three dimensions of acculturation measurements, age of arrival to the U.S., which most likely assumes both cultural assimilation and structural /institutional assimilation the younger an individual arrives in the U.S.,(Gordon, 1964) most strongly suggests a relationship between the “westernized” dietary behavior of SSB consumption and acculturation.

### **SSB consumption and acculturation**

Analysis by the type of SSB and by each of the Asian subgroup revealed unique insights into factors contributing to patterns of SSB intake and acculturation among Asians. This study found that acculturation, measured by age of immigration, increased the odds of SSB consumption. This corresponds with findings from two published studies conducted among Asians living in California and Hawaii (Novotny et al., 2012; Wang et al., 2011) and studies among Latinos (Bermudez, Falcon, & Tucker, 2000; Himmelgreen, Bretnall, Perez-Escamilla, Peng, & Bermudez, 2005) that demonstrated an increase in SSB consumption with higher levels of acculturation. Among types of SSB, this study

found that higher acculturation is associated with increased soda and flavored/sports drinks intake but not with sweetened coffee/tea.

Soda is the single largest contributor to increased SSB consumption among U.S. adults (Bleich et al., 2009; Welsh et al., 2011), especially among Latinos and African Americans. But results from chapter three of this dissertation suggest that sweetened coffee/tea is the main driver of SSB consumption among Asians. The insignificant finding between sweetened coffee/tea and acculturation in this study may be related to the high levels of sweetened coffee/tea consumption that already exists among Asian immigrants. While limited literature shows that the overall consumption of soda is low among Asians comparing to Latinos and African Americans, results from this study demonstrated that acculturation is a strong predictor of increased soda consumption among Asians in two of the acculturation dimensions included in the study. This suggests a differential effect which acculturation has specifically on increased soda consumption compared to other types of SSB among this population. Furthermore, the fact that the “language use/media preference” acculturation dimension demonstrated a significant association only in soda consumption and not in other types of SSB may suggest that exposure to Western culture, such as aggressive soda advertisements in the mainstream media, may play a role in this association (Welch, 2003; Williams, 2011). Further research should be conducted to assess the factors that contribute to this positive association of acculturation and increased soda intake that may not be as apparent in other types of SSB.

In the Asian subgroup analyses, Chinese demonstrated the most number of significant findings in the association of acculturation and increased SSB intake. They

are consistent with the results found among analyses conducted among all Asians, and could be attributed to the large Chinese weighted sample size among the seven subgroups. However, there are also significant associations with increased acculturation and any SSB consumption among Japanese (OR=2.4) and increased odds of soda consumption among Koreans (OR=2.7) in the subgroup analyses.

This study found that Filipinos who immigrated to the U.S. after the age of 18 had increased odds of soda intake compared to those who were U.S. born or arrived before age 18. One explanation could be that although Filipinos constitute 25% of the Asian population in California (and sample weights were adjusted to reflect the proportion in this analysis), the unweighted proportion of Filipinos interviewed in this survey was only 10% of the total Asian respondents (n=505, N=5,062). Therefore, the results may have been too inflated to be truly representative of the actual Filipino population. A second potential explanation is the existing high rates of sugar and syrup consumption in the Philippines (Pedro, Benavides, & Barba, 2005; Tachoco, 2011). Given the paucity of evidence on the association among acculturation and SSB consumption among Filipino Americans, more research is needed to confirm this relationship.

As the immigrant population becomes more diverse in this age of globalization, and with increasing evidence that suggests the differential influence of acculturation on dietary behavior among ethnic sub-populations, researchers have called for greater specificity in the dietary interventions policymakers should consider in relation to acculturation (Ayala et al., 2008; Lara, Gamboa, Kahramanian, Morales, & Bautista, 2005). The current gap in collecting comprehensive information on the varying facets of

acculturation and from ethnic subgroups in population-based health surveys in the U.S. should be addressed.

## **STRENGTHS AND LIMITATIONS**

The strengths of this study are the large sample size of Asian population and the use of various dimensions of acculturation in this population to ascertain their differential associations to SSB consumption. There is limited research that simultaneously examined the association of acculturation on dietary behavior using more than one acculturation measurement in a single study. Data on the relationship between acculturation and SSB consumption among Asians have not been consistent in the literature, and to our knowledge, no study has compared the differences among all seven Asian subgroups in one single study. Researchers that examined relationship between diet and acculturation among Latinos have long argued that there is a need to ascertain the differential association among different Latino subgroups (Arandia, Nalty, Sharkey, & Dean, 2012; Ayala et al., 2008; van Rompay et al., 2012) and this study confirmed that this need extends to the Asian American subpopulations. This study also confirmed the negative effect of higher level of acculturation with increased SSB consumption, at least among certain segments of Asian Americans. Differences in SSB consumption pattern between ethnic groups may be partly explained by diverse subcultures and the complexities within the various ethnic communities in this population.

This study has several limitations. First, although factor analysis was used to capture different aspects of acculturation in the analysis, the survey provided a relatively limited set of questions to assess this complicated process and additional constructs related to acculturation may have been neglected, such as the effect of community and

family influence on acculturation. Second, SSB consumption occasion is self-reported and may introduce recall or social desirability biases, resulting in potential underreporting and unreliability of the measurement. Third, serving size was not included in beverage consumption questions in the CHIS and precluded us from converting reported beverage consumption to caloric intake. Future studies are needed to determine the differences in energy intake of SSB in Asian and its subpopulations. Fourth, this survey was cross-sectional and cannot assess any causal relationships and only associations were drawn between ethnic disparities and SSB consumption. The sample sizes of the subpopulations were relatively small and larger studies are needed to confirm the findings of this study.

Findings from this study may not be generalizable for all Asians living in the U.S., but it is important to note that more than one-third of Asians living in the U.S. reside in California (Census Bureau, 2012). However, given the lack of national level data on dietary behaviors among Asians that would allow for analysis of different Asian subgroups, this study serves as an important step in ascertaining the eating behaviors in this rapidly growing population. And despite these limitations, this study addresses an existing gap concerning the differential associations of acculturation on SSB and the type of SSB consumption among these diverse Asian subgroups.

## **CONCLUSION**

This study found that acculturation was independently associated with increased odds of consuming any sugar-sweetened beverages, including soda and flavored/sports drinks among a population-based sample of Asian Americans residing in California. Furthermore, our results demonstrated that these differences exist among Asian subpopulations, which are often aggregated as one large “race” category in the analyses

of obesity and dietary patterns in large epidemiological studies (Ogden, Carroll, Kit, & Flegal, 2013). The addition of Asian population as a distinct ethnic group in the analysis of the 2011 round of the NHANES is a step forward. However, the cultural and dietary variations within the Asian population, as demonstrated in this study, should not be disregarded.

Assessing the extent of the association between acculturation and SSB may be of particular relevance to dietary modification and prevention approaches in this population. To date, Asian Americans have been the least affected by the obesity epidemic in the U.S. compared to other minorities (Ogden et al., 2013; Ogden, Carroll, Kit, & Flegal, 2014), but evidence has confirmed that a positive relationship exists between acculturation and BMI in this population (Chen et al., 2012; Goel et al., 2004; Maskarinec et al., 2006; Roshania et al., 2008; Sanchez-Vaznaugh et al., 2008). With the association of SSB, an important proxy for poor diet quality, and dimensions of acculturation identified, intervention programs on dietary behavior can be better tailored to the needs of these very different, but rapidly growing Asian subpopulations. Furthermore, this study demonstrated the strong association of early life exposure to the U.S. and increased SSB consumption. Policymakers should consider designing public health interventions that specifically target Asian children and youth from excess SSB consumption as an important primary prevention measure.

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**Table 4.1 Characteristics of adults aged 18 or older in the 2009 California Health Interview Survey (CHIS), by self-reported Asian subgroup**

	Chinese	Japanese	Korean	Filipino	South Asian	Vietnamese	Other Asian
Total population (N=5,062)	1,055	427	950	505	411	1,413	301
unweighted %	21%	8%	19%	10%	8%	28%	6%
weighted %	27%	7%	10%	25%	13%	11%	7%
Age (years) <sup>1</sup>	44.9(1.8)	51.8(1.5)	37.9(1.2)	44.1 (1.0)	38.6 (1.0)	41.6 (1.3)	36.2(1.5) **
Sex, Male (%)	48.2(2.9)	41.0(3.2)	29.5(5.0)	47.6 (3.4)	59.4 (3.8)	52.0 (5.1)	42.7(5.5) **
Education (%)							
<12 years	13.4(3.1)	3.3(1.5)	5.6(1.1)	6.6 (2.5)	2.0 (.7)	14.6 (3.3)	9.7(2.6) **
High School Graduate/Some College	31.6(3.0)	40.8(3.9)	33.6(4.8)	42.6 (3.3)	20.9 (3.2)	53.6 (5.8)	41.0(5.6)
Bachelor's Degree	33.5(3.2)	33.9(3.6)	46.8(5.4)	41.4 (3.7)	27.7 (4.0)	27.0 (4.0)	35.4(5.9)
Master/PhD/ Professional Degree	21.5(2.6)	22.0(3.3)	14.0(2.7)	9.4 (2.0)	49.4 (4.0)	4.8 (1.3)	13.9(3.2)
Non-U.S. Born (%)	76.7(3.1)	21.3(2.7)	62.8(6.0)	65.1 (3.4)	84.6 (4.2)	78.3 (6.1)	62.1(4.8) **
Percent of life living in the U.S.							
>80% or U.S. born	30.5(3.1)	83.9(2.5)	42.6(5.8)	45.1(3.5)	19.0(4.3)	25.2(5.9)	45.8(5.0) **
61-80%	10.6(1.8)	6.4(1.7)	6.8(1.7)	11.5(1.7)	7.2(1.5)	20.2(5.2)	16.5(3.2)
41-60%	24.1(3.0)	3.7(1.3)	14.9(2.1)	20.3(2.5)	20.4(2.5)	21.6(3.7)	16.6(3.3)
40% or less	34.7(3.7)	6.0(1.3)	35.7(5.3)	23.1(2.6)	53.4(4.4)	33.0(4.2)	21.1(4.9)
Language of spoken at home (%)							
English only	15.8(1.9)	78.4(2.7)	15.4(3.1)	38.6(3.1)	21.1(4.5)	9.1(2.7)	40.1(5.5) **
English + other	38.0(3.3)	18.6(2.6)	45.8(5.4)	55.5(3.3)	71.8(4.7)	55.0(6.5)	43.7(4.9)
No English	46.2(3.8)	3.0(0.8)	38.8(5.1)	6.0(1.4)	7.2(1.0)	35.9(5.7)	16.2(3.3)

<sup>1</sup> mean ± standard error

\*p-value <0.05; \*\*p-value <0.01

**Table 4.2 Factors and factor loading of items used to measure acculturation among 2009 California Health Interview Survey Asian adults\* (N=5,062)**

Items on the 2009 CHIS Adult version	Loading weight	Eigenvalue	Variance explained
<i>Language proficiency/cultural preference**</i>		4.84	60.1%
Language spoken at home	0.82		
Self-reported language proficiency	0.87		
Language spoken with friends	0.86		
Language for TV shows, radio, or newspapers	0.83		
<i>Exposure to living in the U.S.</i>		1.10	14.1%
Years living in the U.S.	0.77		
% of life living in the U.S.	0.79		
US born vs. foreign born	0.72		
Generational status	0.71		

*\*Age of arrival to the U.S. was demonstrated as a shared component ("crossloading" variable) and was taken out of the factor analysis to be assessed as a separate variable*

*\*\*Options included: Only English, Both English and Other Language(s), and Other Language(s) only*

**Table 4.3 Mean consumption of sugar sweetened beverage over the past 7 days by acculturation dimensions among Asian adults in the 2009 California Health Interview Survey**

	Age of arrival in the U.S. <sup>1</sup>			Time exposure to the U.S. dimension				Language/media preference dimension			
	>18 years n=3,070	<18 years n=1,992		low	medium	high		low	medium	high	
Total population (N=5,062) <sup>2</sup>											
Total SSB consumption per week	5.9(0.4)	6.5(0.3)		6.3(0.4)	5.7(0.4)	6.5(0.4)		4.9(0.5)	6.4(0.4)	6.6(0.3)	**
Soda	1.0(0.1)	1.7(0.1)	**	1.1(0.1)	1.2(0.2)	1.6(0.1)		0.5(0.1)	1.3(0.2)	1.7(0.1)	**
Coffee/Tea	3.8(0.2)	2.7(0.2)	**	3.8(0.3)	3.2(0.2)	2.8(0.2)	*	3.4(0.5)	3.6(0.2)	2.8(0.2)	*
Flavored fruit drinks	0.8(0.1)	1.2(0.1)	*	1.0(0.1)	0.9(0.1)	1.2(0.1)		0.8(0.1)	1.0(0.2)	1.2(0.1)	
Sports drinks	0.3(0.1)	0.9(0.1)	**	0.4(0.1)	0.4(0.1)	1.0(0.1)	**	0.2(0.0)	0.5(0.2)	0.9(0.1)	**

<sup>1</sup>United States; <sup>2</sup> Analysis of variance (ANOVA) tests were performed. \*p-value <0.05; \*\* p-value <0.01



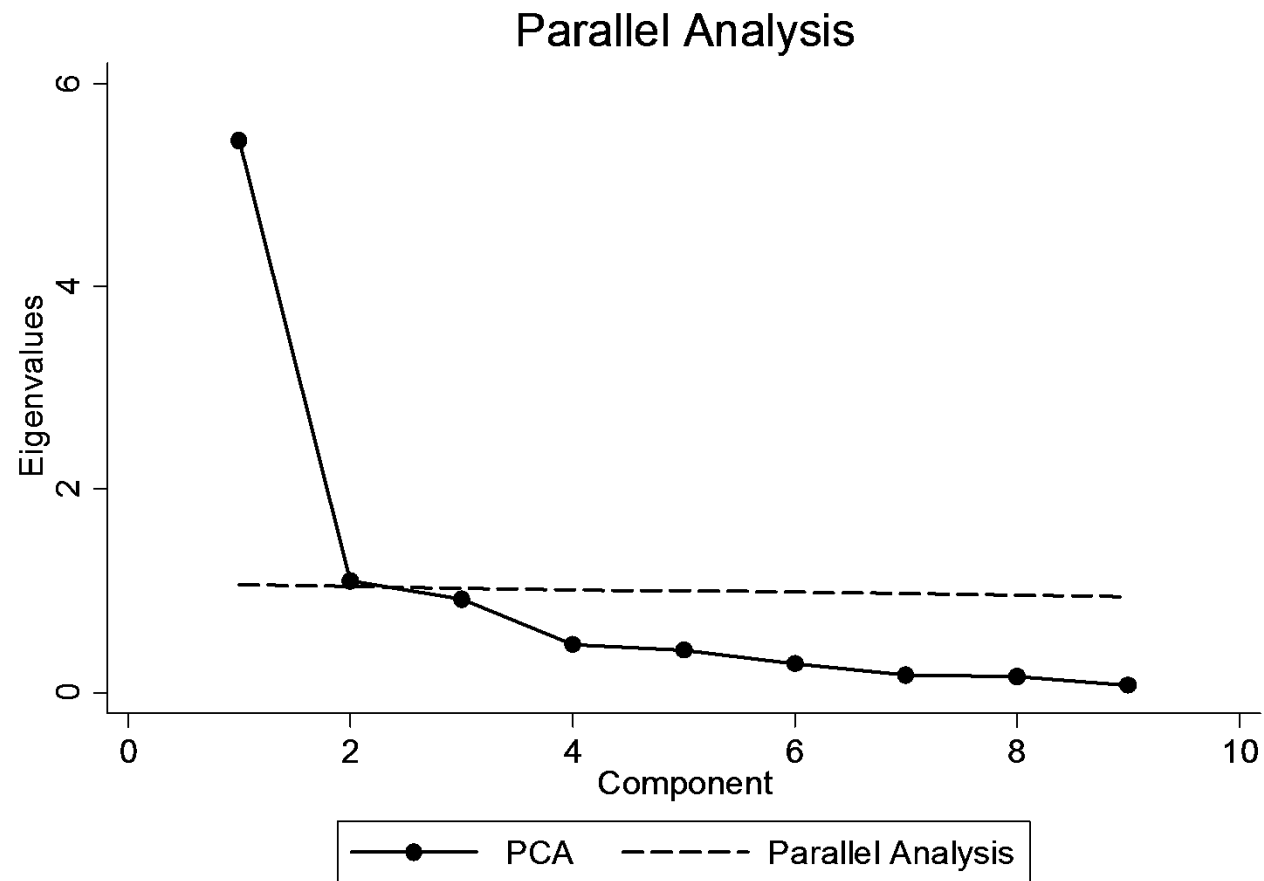
**Table 4.4 Adjusted odds ratios of no sugar-sweetened beverage (SSB) vs. any SSB consumption in the past 7 days, by acculturation dimensions, in the 2009 California Health Interview Survey Adult Asian population (N=5,062)**

	Model 1		Model 2				
	Arrived in U.S. <sup>1</sup> before age 18 or U.S. born		Time Exposure to U.S. Component		Language proficiency/media preference Component		
			Medium	High	Medium	High	
Any SSB consumption in past week							
All Asian subgroups <sup>2</sup>	1.8 [1.2-2.7]	**	1.1 [0.7-1.7]	1.3 [0.8-2.3]	1.4 [0.9-2.4]	1.3 [0.7-2.5]	
Chinese	2.8 [1.3-6.0]	**	1.1 [0.5-2.7]	2.8 [1.2-6.9]	* 1.3 [0.6-2.8]	0.7 [0.3-2.0]	
Japanese	2.4 [1.1-4.6]	*	1.1 [0.3-3.6]	2.5 [ 0.8-8.4]	5.1 [0.9-29.3]	1.9 [0.3-11.4]	
Korean	0.7 [0.3-1.9]		1.3 [0.6-2.8]	0.5 [0.2-1.4]	0.5 [0.2-1.4]	1.9 [0.6-6.7]	
Filipino	0.4 [0.1-1.2]		1.4 [0.6-3.2]	0.6 [0.2-2.6]	0.9 [0.2-4.8]	0.4 [0.6-2.8]	
South Asian	3.1 [0.7-5.3]		0.8 [0.3-2.0]	1.5 [0.2-13.0]	0.5 [0.1-2.5]	1.8 [0.3-11.8]	
Vietnamese	2.1 [0.5-8.7]		0.9 [0.3-2.6]	1.7 [0.2-23.8]	1.4 [0.5-3.6]	1.3 [0.3-9.5]	
Other Asian	1.5 [0.4-5.4]		0.6 [0.2-2.0]	0.5 [0.2-1.8]	0.7 [0.1-4.7]	0.7 [0.1-6.7]	
Any soda consumption in past week							
All Asian subgroups	1.3 [1.0-1.7]	*	1.2 [0.8-1.7]	0.8 [0.6-1.1]	1.8 [1.2-2.9]	** 1.8 [1.2-2.8]	**
Chinese	2.2 [1.2-4.3]	*	1.3[0.7-2.7]	1.1 [0.4-3.0]	1.4 [0.7-2.7]	1.7 [0.6-5.3]	
Japanese	1.4 [0.6-3.7]		0.4 [0.1-1.6]	0.3 [0.1-1.1]	1.1 [0.1-4.2]	1.3 [0.4-29.6]	
Korean	2.0 [0.7-6.0]	*	0.9 [0.3-2.5]	1.1 [0.2-6.2]	2.7[1.0-7.3]	* 2.6 [0.5-14.1]	
Filipino	0.4 [0.2-0.8]	*	0.9 [0.4-2.0]	0.5 [0.2-1.4]	1.3 [0.3-5.8]	0.5 [0.2-1.4]	
South Asian	0.7 [0.3-1.8]		1.2 [0.5-2.6]	0.4 [0.2-1.7]	0.4 [0.1-2.1]	0.7 [0.1-3.2]	
Vietnamese	2.0[0.8-5.0]		0.9 [0.4-2.0]	0.5 [0.1-2.5]	1.6 [0.7-3.8]	3.4 [0.7-15.8]	
Other Asian	1.1 [0.5-2.8]		0.4 [0.2-1.3]	0.6 [0.2-1.6]	1.8 [0.4-8.2]	1.4 [0.3-6.1]	
Any flavored/sports drink consumption in past week <sup>3</sup>							
All Asian subgroups	1.3 [1.0-1.7]	*	1.0 [0.8-1.3]	1.0 [0.6-1.3]	0.9 [0.6-1.4]	1.3 [0.8-2.1]	
Any coffee consumption in past week <sup>3</sup>							

All Asian subgroups	1.1 [0.8-1.6]	0.8 [0.6-1.2]	0.9 [0.6-1.2]	1.5 [1.0-2.2]	1.2 [0.8-1.8]
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<sup>1</sup> United States; <sup>2</sup> Odds Ratio with 95% Confidence Interval; Results were adjusted for sociodemographic factors including age, gender, marital status, poverty, education, physical activity level, self-reported diabetes, and self-reported health status; <sup>3</sup> All sub-group analyses results were not statistically significant.

#### Annex 4.1 Parallel Analysis of Eigenvalues of Acculturation Components based on Factor Analysis



## **CHAPER 5: NEIGHBORHOOD RACIAL/ETHNIC DENSITY AND SUGAR-SWEETENED BEVERAGE CONSUMPTION AMONG ADULTS LIVING IN CALIFORNIA**

### **ABSTRCT**

**Background:** Growing evidence suggests that residential environment such as neighborhood ethnic density and neighborhood socioeconomic status may play an important role in health disparities, including those related to diet and lifestyle. The obesity epidemic in the US has prompted a closer examination of those factors on dietary energy intake, particularly of sugars and sugar-sweetened beverages (SSB).

**Objectives:** To assess the association between neighborhood ethnic densities and sugar-sweetened beverage consumption, among non-Hispanic White, Hispanic, African American, and Asian adults living in California.

**Methods:** Cross-sectional analysis of 45,966 adults aged 18 or older (including a subsample of 4,761 self-reported Asians) who participated in the 2009 California Health Interview Survey. Geographic data from the survey were merged with the 2010 U.S. Census and 2009 U.S. Census business data to assess neighborhoods with various ethnic densities and their associations with sugar-sweetened beverage consumption. Multivariate odds ratios were calculated by logistic regressions with robust variance estimates.

**Results:** Our findings indicate that SSB consumption is higher in neighborhoods with ethnic density of  $\geq 25\%$  Hispanics, compared to those who live in neighborhoods with other ethnic densities, regardless of race/ethnicity. Findings in neighborhoods with  $\geq 25\%$

Asians were equivocal in which the only significant results were among Hispanics residents who had a decreased odds of soda consumption, but they also had an increased odds of flavored/sports drinks compared to their Hispanic counterparts (White: OR 1.3, 95% CI: 1.2-1.5,  $p<0.01$ ; Hispanic: OR 1.3, 95% CI: 1.0-1.6,  $p<0.05$ ; Asian: OR 1.5, 95% CI: 1.1-2.0,  $p<0.01$ ; African American OR 1.8, 95% CI: 1.2-2.7,  $p<0.01$ ).

**Conclusion:** Additional research is needed to explore why neighborhoods with higher density of Hispanics compared to those with lower density of Hispanics are associated with increased soda consumption in California, regardless of the race of those living in such communities. Understanding the underlying factors can enable policymakers to better define and target prevention interventions on SSB consumption in these neighborhoods. Researchers should also further explore the relationship between Asian ethnic neighborhoods and health behaviors/outcomes in the absence of consistent findings in this area.

## INTRODUCTION

Evidence from national surveys conducted in the U.S. suggests that the self-reported amount of food and beverages, total energy intake, and the amount of food and calories per eating episode experienced an increase in secular trend between 1977 and 2002 (Kant & Graubard, 2006). At the same time, the consumption of added sugars and sugar-sweetened beverages (SSB) in the U.S. has increased dramatically, and its temporal patterns parallel the rise in obesity (Bleich, Wang, Wang, & Gortmaker, 2009; Malik, Popkin, Bray, Despres, & Hu, 2010; Welsh, Sharma, Grellinger, & Vos, 2011). Between 1977 and 2001, the percent of calories from all beverages in the U.S. increased by more than 50% while the prevalence of obesity among U.S. adults doubled (Duffey & Popkin, 2007; Flegal, Carroll, Ogden, & Johnson, 2002). Despite the recent plateau in the prevalence of obesity (Flegal, Carroll, Ogden, & Curtin, 2010; Flegal, Carroll, Kit, & Ogden, 2012; Ogden, Carroll, Kit, & Flegal, 2013; Ogden, Carroll, Kit, & Flegal, 2014) and a moderate decrease in SSB consumption over the past few years (Kit, Fakhouri, Park, Nielsen, & Ogden, 2013; Ogden, Kit, Carroll, & Park, 2011; Welsh et al., 2011), sugar from SSB continues to be the largest single contributor to caloric intake in the U.S. (Welsh et al., 2011). Furthermore, evidence overwhelmingly supports a positive association between SSB consumption and the risk of obesity (Hu & Malik, 2010; Malik, Schulze, & Hu, 2006; Malik, Popkin, Bray, Despres, & Hu, 2010; Malik, Pan, Willett, & Hu, 2013; Mozaffarian, Hao, Rimm, Willett, & Hu, 2011; Schulze et al., 2004; Vartanian, Schwartz, & Brownell, 2007). Aside from contributing to the obesity epidemic in the U.S., the consumption of SSB has also been associated with an increased risk of chronic

diseases such as Type II diabetes and coronary heart disease (de Koning et al., 2012; Hu & Malik, 2010; Malik et al., 2010).

The disproportionate effects of obesity and SSB consumption on minorities including African Americans and Hispanics have been well studied (Bleich et al., 2009; Duffey & Popkin, 2007; Han & Powell, 2013; Kit et al., 2013; Ogden et al., 2014; Y. Wang & Beydoun, 2007), while a small number of studies have assessed the consumption of SSB among Asians (Han, Kim, & Powell, 2013; Lv & Cason, 2004; Novotny et al., 2012; S. Wang, Quan, Kanaya, & Fernandez, 2011). **Chapter three** of this dissertation demonstrated that Asian Americans consumed significantly more sweetened coffee/tea compared to Whites, while they consumed significantly less soda compared to Hispanics and African Americans. Individual factors such as income, education, and acculturation may partially explain these observed ethnic differences in SSB consumption and other dietary behaviors. However, a growing body of evidence suggests that neighborhood level characteristics such as food and built environments are associated with dietary behavior after accounting for individual-level variations (Bleich, Thorpe, Sharif-Harris, Fesahazion, & Laveist, 2010; Dubowitz, Subramanian, Acevedo-Garcia, Osypuk, & Peterson, 2008; Giskes, Avendano, Brug, & Kunst, 2010; Inagami, Cohen, Brown, & Asch, 2009; Kershaw, Albrecht, & Carnethon, 2013; Kimbro & Denney, 2012; Larson, Story, & Nelson, 2009; Mujahid et al., 2008; Osypuk, Diez Roux, Hadley, & Kandula, 2009; Papas et al., 2007; Sallis, Floyd, Rodriguez, & Saelens, 2012).

Over the past decade, public health literature on the effects of neighborhoods and health has grown enormously (Weden, M.M. 2008, Cummins, S. 2007). A number of contextual factor measurements have been used in health research to characterize

neighborhoods and their associations with health outcomes, including neighborhood poverty/disadvantage ( Wilcox,S. 2013; Wen,M. 2011; Osypuk,T.L. 2010; Zenk,S.N. 2005; Krieger,N. 2003; Ross,C.E. 2001; Powell-Wiley,T.M. 2014) , neighborhood affluence (Massey,D.S. 1996; Browning,C.R. 2003; Cagney,K.A. 2005; Wen,M. 2003; Hou,F. 2005) , ethnic composition (Froment,M.A. 2014; Kirby,J.B. 2012; Kirby,J.B. 2012; Walton,E. 2012; Reyes-Ortiz,C.A. 2009; Wen, M. 2009; Do,D.P. 2007) , residential segregation (Borrell,L.N. 2013; Kershaw,K.N. 2013; Corral,I. 2012; Quillian,L. 2012; Debbink,M.P. 2011; Kershaw,K.N. 2011; White,K. 2011; Kramer,M.R. 2010; Landrine,H. 2009; Walton,E. 2009; Kwate,N.O. 2008; Lee,M.A. 2007; Chang,V.W. 2006; Acevedo-Garcia,D. 2003), social cohesion, network, capital (Mulvaney-Day,N.E. 2007; Browning,C.R. 2002; Caughy,M.O. 2003; Harpham,T. 2004; Carpiano,R.M. 2007), and access to services (Wilcox,S. 2013; Sallis,J.F. 2012; Wen,M. 2011; Lisabeth,L.D. 2010; Larson,N.I. 2009; Papas,M.A. 2007; Truong,K. 2010).

Regardless of how neighborhoods were measured, evidence suggests that neighborhoods and environmental factors play an important role in health (Weden, M.M. 2008). For example, obesity has found to be associated with food environment and neighborhood socioeconomic status, and individuals residing in disadvantaged neighborhoods are at an increased risk of being overweight (Black,J.L. 2008; Dubowitz,T. 2012; Wang,Y. 2007; Morland,K. 2006; Kershaw,K.N. 2013; Corral,I. 2012; Kimbro,R.T. 2012; Kirby,J.B. 2012; Moore,L.V. 2006).

In addition to assessing the socioeconomic status of neighborhoods, there is an increased interest among researchers in recent years to examine the ways neighborhood ethnicity affect health and health outcomes (Becares,L. 2012; Shaw,R.J. 2012; 323



Hong,S. 2014). A systematic review on ethnic density effects and their association with morbidity, mortality, and health behaviors demonstrated that the majority of existing literature (42 of 57 papers included) focused on African Americans, while only 15 studies were among Hispanics living in the U.S. (Becares,L. 2012). Overall, neighborhoods with higher composition of African Americans were mostly found to be adversely associated with health. The majority of studies (four out of five) that examined the association between body mass index and African American ethnic density found a negative effect on obesity (Chang,V.W. 2006; Chang,V.W. 2009; Do,D.P. 2007; Park,Y. 2008; Robert,S.A. 2004). Furthermore, a number of studies have found that residing in these neighborhoods are associated with poor diet quality among African Americans (Dubowitz et al., 2008; Kershaw et al., 2013; Kwate, 2008).

Findings related to Hispanic American adults between ethnic neighborhoods and dietary behavior are less consistent compared to African Americans, and research on Asians in this area is limited (Acevedo-Garcia, 2001; Acevedo-Garcia, Lochner, Osypuk, & Subramanian, 2003; Eschbach, Ostir, Patel, Markides, & Goodwin, 2004; Gee, 2002; Kramer & Hogue, 2009; Lee & Ferraro, 2007; Patel, Eschbach, Rudkin, Peek, & Markides, 2003; Reyes-Ortiz, Ju, Eschbach, Kuo, & Goodwin, 2009; Walton, 2012). The systematic review conducted by Becares et al found that neighborhoods with higher composition of Hispanics to be protective in regards to infant mortality, birth weight, and smoking during pregnancy, but the associations with other health behaviors (including nutrition) were less salient (Becares,L. 2012) . One study found that Mexican Americans living in census tracts with higher percentages of Hispanics had poorer diet quality (lower consumption of vegetables) compared to individuals living in areas with fewer

percentage of Hispanics (Reyes-Ortiz et al., 2009). Other studies have found that Hispanics residing in higher Hispanic composition neighborhoods exhibited healthier dietary patterns (Dubowitz et al., 2008; Park et al., 2011).

Recent research has found that Asian ethnic neighborhoods have lower exposure to social and structural disadvantages (J. Logan, 2011), and one study demonstrated that living in Asian neighborhoods are associated with higher birth weight for newborns (Walton, 2009). Another study found that individuals living in neighborhoods with high concentrations of Asians had a lower obesity rates and had lower average BMI compared to those living other communities (Kirby et al., 2012). With regards to dietary behavior and ethnic neighborhoods among Asians, one recent study demonstrated that living in census tracts with a higher proportion of immigrants from China was associated with lower consumption of high-fat foods among Chinese adults (Osypuk et al., 2009).

In regards to neighborhood ethnic diversity, there exist a relatively small number of studies that examine the relationship between racially mixed neighborhoods, majority-minority neighborhoods and health. Findings from existing studies have been inconclusive. Vang et al examined the association of minority diversity (majority-minority neighborhoods) and birthweight and found to have a protective effect (Vang,Z.M. 2013). However, another study examining mixed neighborhoods and birth outcomes found that African American women living in these mixed neighborhoods did not demonstrate a reduced risk of preterm birth or low birthweight (Pickett,K.E. 2005). Furthermore, one study assessing the overall health status of youth in racially mixed neighborhoods found a negative effect (Abada,T. 2007).

Little is known, however, about how ethnic composition of neighborhoods and majority-minority neighborhoods are associated with individual's dietary behavior and whether such an association would differ by individual race/ethnicity.

The demographic landscape of California is unique in that it is one of the most ethnically diverse states in the U.S. ,with 37% of the total population reported as Hispanic, and 13% reported as Asian (Census Bureau 2012; Census Bureau 2012; Humes, K. 2011). It is also one of the four “majority-minority” states in the U.S. where non-Hispanic Whites are not considered a majority (Census Bureau 2012). Given the limited research on how neighborhoods ethnicity relate to dietary behavior in an increasing ethnically diverse country, this study aimed to assess the association of neighborhoods with different ethnic densities and SSB consumption, an important contributor to the obesity epidemic, among adults living in California (Goel, McCarthy, Phillips, & Wee, 2004; Gordon-Larsen, Harris, Ward, Popkin, & National Longitudinal Study of Adolescent Health, 2003; Hu, 2013; Malik et al., 2013; Nielsen & Popkin, 2004; Vartanian et al., 2007). We hypothesize that different ethnic profiles/densities of neighborhoods are associated with different SSB consumption patterns. Specifically, we hypothesized that the predominant ethnic group in a neighborhood can modulate the SSB consumption pattern of the other groups in that neighborhood.

## **METHODS**

### **Study design and data sets**

This study used data from the 2009 California Health Interview Survey (CHIS). CHIS 2009 is a population-based survey and is the largest health survey ever conducted in any state. The 2009 CHIS surveyed 47,614 adults using a two-stage geographically

stratified random digit dial (RDD) sample design. It was designed to produce reliable estimates of various health parameters for large- and medium-sized counties in the state, and for groups of the smallest counties. It also provides statewide estimates for California's overall population, including its major racial and ethnic groups and Asian and Latino ethnic subgroups. A complete description of data collection procedures and analytic guidelines are available elsewhere (<http://www.askchis.com/designs-methods.html>).

The 2010 U.S. Census tract-level data was used to obtain neighborhood racial/ethnic density, percent of foreign born, median income per capita, and neighborhood poverty rate. Neighborhood level indicators pertaining to business density at the zip code level (i.e. grocery stores, convenience stores, fast-food restaurants and dine-in restaurants) were obtained using the 2009 U.S. Census Business data.

### **Study Sample**

The study sample consisted of all non-institutionalized individuals aged  $\geq 18$  years old residing in California at the time of the interview conducted between September 2009 and April 2010. While using a nationally representative sample may be more generalizable, it is often limited in scope when assessing minority populations such as Asian Americans, due to limited sample size for this population. The diverse ethnic composition in California makes the CHIS a useful instrument to study ethnic disparities beyond African American and Hispanic populations. Survey respondents are excluded if they were pregnant at the time of data collection. A total of 45,966 individuals were included in the study, of which 4,761 Asians were included in the Asian subgroup analysis.

## **Measures**

### *Sugar-sweetened beverages (SSB)*

For sugar-sweetened beverages, the study included carbonated soft drinks, sugar-sweetened coffee and tea, and non-carbonated SSB such as flavored fruit punches, lemonade, energy drinks and sports drinks. Survey respondents reported how often they consumed the following four types of SSB: soda, fruit drinks, energy drinks/sports drinks, and coffee/tea. Respondents had the option of answering in terms of the number of times per day, week, or month. For the analyses, all responses were converted to number of times per week.

Outcome responses for the total consumption of SSB were categorized by the amount of sweetened beverages they consumed into none in the past seven days vs. any consumption over the past seven days. Diet beverages and unsweetened coffee/tea were not included in these analyses. Flavored fruit drinks and energy drinks/sports drinks were combined into one variable due to the relatively low percentages of individuals who reported consumption within the past seven days.

### *Health behavior*

General health status (from poor to excellent) was categorized into poor/fair, good, and very good/excellent. Self-reported diabetes status was categorized into diabetes, pre-diabetes/borderline, and no diabetes.

### *Race, ethnicity and nativity*

Race and ethnicity were categorized based on the 1997 Office of Management and Budget (OMB) standards for vital records collection into 1) Non-Hispanic White, 2) Hispanic, 3) Non-Hispanic Black, and 4) Non-Hispanic Asian. “Other Races” including

Pacific Islanders, American Indians, Alaskan Natives, and two or more races were excluded due to their small sample sizes. Nativity (U.S. vs. foreign born) and age of arrival to the U.S. for those who were foreign born were also included in this study.

#### *Sociodemographic status*

Age was categorized into 18-39, 40-59, and 60+ years old and marital status was classified into three categories (married/living together, separated/divorced/widowed, and never married). Four educational attainment categories (master's degree or higher, college graduate, high school graduates/some college, and less than high school) and four family income levels expressed as a percentage of the federal poverty level (FPL) of  $\geq 300\%$ , 200-299%, 100-199%, and  $\leq 99\%$  are included. Age of arrival in the U.S. ( $<18$  vs.  $\geq 18$  years old) for all foreign-born respondents was also included.

#### *Neighborhood level variables*

##### *Neighborhood Racial/Ethnic Density*

In the basic descriptive tables (Tables 5.1-5.5), a series of ethnic density gradients were created based on the distribution of the 2010 Census data to describe the varying characteristics of ethnic density for the different neighborhoods at the census tract level. In the multiple logistic regressions, neighborhood racial/ethnic densities were measured using three dichotomous variables of “Less than 50% White,” “more than 25% Asian,” and “more than 25% Hispanic” in the 2010 Census tract data; they were not mutually exclusive. For example, a census tract can be both “less than 50% White” and “More than 25% Hispanic”. Different ethnic percentages ranging from 10%-35% for Asian and Hispanic neighborhoods and “less than 40%-75% White” were used to assess the sensitivity of the 25% and  $<50\%$  cutoffs in the regressions, respectively. The

proportion of individuals residing in neighborhoods with “more than 25% African American” was too low to be meaningfully included in the analysis. Therefore, a variable on ethnic neighborhoods for African Americans was not created.

#### *Poverty rate and median income per capita*

The percent of residents living under the 2010 federal poverty line at the tract level was included in the 2009 CHIS and median income per capita was included in the 2010 Census data.

#### *Foreign born*

The percent of residents who were born outside of the U.S. at the tract level was included.

#### *Food environment*

Density (number of stores per 1,000 population) of grocery stores, convenience stores, fast-food and dine-in restaurants measured at the zip code level using the 2009 Census Business data were included in the analysis. They were linked individually based on the residence zip code of the respondents in the study. The North American Industry Classification System (NAICS), a standard used by the Federal statistical agencies for business establishments, was used to classify grocery stores, convenience stores, fast-food and dine-in restaurants at the zip-code level.

### **Statistical Analysis**

The 2010 Census data was first analyzed by varying gradients of ethnic density to assess the overall characteristics and ethnic distribution of neighborhoods in California. The 2009 CHIS was then merged and linked with the 2010 Census at the tract level to generate neighborhood racial/ethnic density variables, neighborhood poverty level and

neighborhood foreign-born percentages for each individual in the 2009 CHIS. The 2009 Census Business Data was merged with the 2009 CHIS to generate grocery stores, convenience stores, fast-food and dine-in restaurants density variables.

All analyses using the CHIS were weighted to be representative of the non-institutionalized adult population in California using STATA version 11 (Stata Corp, College Station, TX). Multivariate logistic regressions were used to investigate the association between neighborhood racial/ethnic density and SSB consumption. Two models were included: one with all non-Hispanic White, Hispanic, African American and Asian adults and, the other with a stratified analysis of the Asian sub-populations. The types of SSB consumed were categorized as dichotomous outcomes. Weighted means with standard errors and frequencies were assessed for all continuous and categorical variables by race/ethnicity and/or level of neighborhood racial/ethnic density. In order to account for the complex sampling structure, jackknife variance estimation method was used to compute and adjust for the standard error estimates.

Based on weighted regression models, the multivariate-adjusted odds ratios and 95% confidence intervals for each race/ethnicity and the Asian sub-groups were assessed in this study. Tests for interaction between ethnic concentration and gender, ethnic concentration and age, ethnic concentration and race/ethnicity, ethnic concentration and poverty, and ethnic concentration and education on SSB consumption were performed to assess whether the association of neighborhood racial/ethnic concentration and SSB consumption varied by these factors.



## RESULTS

**Tables 5.1** and **5.2** present the descriptive statistics of the 2010 Census data by ethnic densities. Overall, 63.8% of the total population California reside in neighborhoods with <50% White, 57.7% live in neighborhoods with  $\geq 25\%$  Hispanics, 15.6% live in neighborhoods with  $\geq 25\%$  Asians and 17.5% in neighborhoods with  $\geq 10\%$  African American by census tracts. The percentage of foreign born is lower and the median income per capita is higher in neighborhoods with higher density of non-Hispanic Whites. Neighborhoods with higher density of Hispanics and Asians have higher percentages of foreign born. Neighborhoods with higher density of Hispanics and African Americans have lower median income per capita, while neighborhoods with higher density of non-Hispanic Whites and Asians have higher median income per capita.

**Table 5.2** presents the overall distribution of ethnic minorities living in California using the 2010 Census data. On average, 84.8% of all Hispanics, 77.1% Asians, and 86.1% of African Americans living in California reside in majority-minority neighborhoods with <50% non-Hispanic White. In regards to neighborhoods with  $\geq 25\%$  Hispanics, 44.9% of all Asians living in California reside in these neighborhoods, while 84.5% of all Hispanics living in California reside in them. Over 50% of the total Asian population in California reside in neighborhoods  $\geq 25\%$  Asian, while 60.4% of all African Americans in California reside in neighborhoods  $\geq 10\%$  African American.

As expected with the population-weighted adjustments in the 2009 California Health Interview Survey, **Tables 5.3-5.4** describe similar neighborhood characteristics by ethnic density when compared to the characteristics found in **Tables 5.1-5.2** using the 2010 Census data. **Table 5.5** describes the frequency and the types of sugar-sweetened

beverage consumption occasion by ethnic density. It demonstrates that a decrease in the density of non-Hispanic White in neighborhoods and an increase in the density of Hispanics in neighborhoods are associated with an increase in SSB consumption occasion. The increase in the density of Asian in neighborhoods does not demonstrate an association with increased SSB consumption.

**Table 5.6** presents individual and neighborhood characteristics of the 2009 CHIS study sample by race/ethnicity for all populations while **Table 5.7** reports the same descriptive characteristics of the Asian sub-populations. Overall in the 2009 CHIS study sample, 47% of individuals were non-Hispanic White, with Hispanics constituting 31%, Asians 13%, and African Americans 6% of the weighted population respectively. Hispanics consumed the highest frequency of total SSB ( $9.2 \pm 0.2$  in the last 7 days), followed by African Americans ( $8.4 \pm 0.6$  in the last 7 days). There were significant differences among whites, Hispanics, Asians, and African Americans with respect to sex, age, education, marital status, poverty level, fast-food and SSB consumption.

Based on data from the 2009 CHIS, all three ethnic minorities (Hispanic, African American, and Asian) were more likely to live in census tracts with higher percentages of poverty, compared to non-Hispanic Whites. Overall, Hispanics and Asians were more likely to reside in neighborhoods (census tracts) where more than 25% of the residents shared similar race/ethnicity, and the majority of non-Hispanic Whites resided in neighborhoods where at least 50% were non-Hispanic Whites. Minority populations were also significantly more likely to reside in neighborhoods with higher compositions of different ethnic minorities from themselves (i.e. 67.8% of African Americans residing in neighborhoods of  $\geq 25\%$  Hispanics), higher percentages of foreign-born populations

and higher neighborhood poverty levels, compared to their non-Hispanic White counterparts. All three ethnic minorities resided in neighborhoods with lower densities of fast-food restaurant and convenience store, compared to White.

Among the Asian sub-populations in **Table 5.7**, South Asians had the highest SSB frequency consumption ( $7.9 \pm 0.6$  in the last 7 days), followed by Filipinos ( $6.4 \pm 0.2$  in the last 7 days) and Vietnamese ( $6.4 \pm 0.7$  in the last 7 days). More than 50% of Chinese, Vietnamese and South Asians resided in neighborhoods with  $\geq 25\%$  Asians, while Filipinos had the highest percentage of individuals residing in neighborhoods with  $\geq 25\%$  Hispanics ( $59.7\% \pm 3.3$ ). Japanese and South Asian were the most educated, most likely to reside in neighborhoods with  $>50\%$  Whites, and live in neighborhoods with the lowest levels of poverty rates compared to other Asian subgroups.

**Figures 5.1-5.3** demonstrate the multivariate logistic regression analyses for various types of SSB consumption by race/ethnicity in neighborhoods with various ethnic densities. These figures estimate the odds of different types of SSB consumption in each type of neighborhood (namely  $<50\%$  non-Hispanic White vs.  $\geq 50\%$  non-Hispanic White;  $<25\%$  Hispanic vs.  $\geq 25\%$  Hispanic, and  $<25\%$  Asian vs.  $\geq 25\%$  Asian) when individual and neighborhood characteristics related to SSB consumption are adjusted.

**Figure 5.1** shows the odds of any soda, coffee/tea, or flavored/sports drink consumption in neighborhoods composed of  $<50\%$  non-Hispanic White by race/ethnicity. It shows that non-Hispanic Whites have higher odds of soda consumption when they reside in neighborhoods that are  $<50\%$  non-Hispanic White (OR: 1.24, 95% CI: 1.07-1.45,  $p < 0.01$ ). Moreover, Hispanics consume more coffee (OR: 1.29, 95% CI: 1.06-1.55,  $p < 0.05$ ), and flavored/sports drinks (OR: 1.25, 95% CI: 1.00-1.55,  $p < 0.05$ ) in these

neighborhoods compared to their ethnic counterparts living in neighborhoods with  $\geq 50\%$  non-Hispanic White.

**Figure 5.2** shows the association of SSB consumption by race/ethnicity residing in neighborhoods with  $<25\%$  Hispanic vs. those living in neighborhoods with  $\geq 25\%$  Hispanics. The odds of any soda consumption is higher for individuals, regardless of race/ethnicity, when they reside in neighborhoods with  $\geq 25\%$  of Hispanics compared to their respective ethnic counterparts who do not live in these census tracts. The highest odds of any soda consumption was among African Americans (OR: 1.81; 95% CI: 1.22-2.69,  $p < 0.05$ ), followed by Asians (OR: 1.49; 95% CI: 1.11-2.00,  $p < 0.01$ ), non-Hispanic Whites (OR: 1.32, 95% CI: 1.17-1.50,  $p < 0.01$ ), and Hispanics (OR: 1.27; 95% CI: 1.03-1.55,  $p < 0.05$ ). There is also increased odds of flavored/sports drinks among Asians residing in these neighborhoods (OR: 1.52; CI: 1.12-2.09,  $p < 0.01$ ).

**Figure 5.3** presents adjusted odds ratios of any soda, coffee/tea, or flavored/sports drink consumption in neighborhoods with  $\geq 25\%$  Asians compared to neighborhoods with  $<25\%$  Asians. The associations in the Asian neighborhoods were weaker compared to the other neighborhoods in this study and the results were mixed. The only significant associations found were among Hispanic adults; the odds of any soda consumption was lower (OR: 0.72; 95% CI: 0.53-0.96,  $p < 0.05$ ), while the odds of flavored/sports drinks consumption was higher (OR: 1.34; 95% CI: 1.05-1.73,  $p < 0.05$ ), compared to their Hispanic counterparts not residing in neighborhoods with  $\geq 25\%$  Asian.

The results of the Asian subgroup analysis of the adjusted odds of any SSB consumption are presented in **Figure 5.4**. With the exception of Vietnamese, all Asian subpopulations who reside in neighborhoods with  $\geq 25\%$  Hispanics had higher odds of

any SSB consumption, although none of the findings were statistically significant. In neighborhoods where non-Hispanic Whites constituted <50% of the population, Korean (OR: 2.74, 95% CI: 1.58-4.73,  $p < 0.01$ ), Japanese (OR: 1.90, 95% CI: 1.00-3.5,  $p < 0.05$ ), and South Asian adults (OR 2.93, 95% CI: 1.19-6.23,  $p < 0.05$ ) were at greater odds of consuming any SSB within the past seven days. The only marginally significant finding in the Asian ethnic neighborhood was among Koreans; individuals were 1.89 times (CI: 1.00-3.58,  $p = 0.05$ ) more likely to consume any SSB, compared to their Korean counterparts not living in ethnic Asian neighborhoods.

## DISCUSSION

We investigated the associations of neighborhoods with different ethnic density and SSB consumption among non-Hispanic White, Hispanic, African American, and Asian adults, in addition to a stratified analysis among six Asian sub-populations in California. First, there was evidence to suggest that, after accounting for individual and neighborhood level factors, living in neighborhoods with  $\geq 25\%$  Hispanics (in which over 80% of all Hispanics living in California reside) is associated with increased odds of any soda consumption, regardless of race/ethnicity compared to neighborhoods with <25% Hispanics (in which these neighborhoods were composed of 64.7% non-Hispanic White and 17.0% Asian based on data from the 2010 U.S. Census). Second, the positive associations between SSB and neighborhoods were less compelling among individuals living in neighborhoods with <50% non-Hispanic Whites. Only non-Hispanic White and Hispanic adults were more likely to consume soda and only Hispanics were more likely to consume flavored/sports drinks, compared to their ethnic counterparts not living there. Third, findings in neighborhoods with higher density of Asians ( $\geq 25\%$ ) compared to

<25% Asian neighborhoods were equivocal in which the only significant results were among Hispanics residents who had decreased odds of soda consumption, but also increased odds of flavored/sports drinks compared to their Hispanic counterparts. Fourth, in the Asian subgroup analysis, increased odds of total SSB consumption were fairly consistent across the Asian subpopulations in neighborhoods and with  $\geq 25\%$  Hispanics and majority minority neighborhoods, although only a few of these findings were significant.

Neighborhoods with high concentration of ethnic minorities, especially among African Americans, have been found to adversely affect health outcomes (Chang, 2006; Corral et al., 2012; Jackson et al., 2000; Kershaw et al., 2011; Kershaw et al., 2013; Kramer et al., 2010; Landrine & Corral, 2009). However, findings related to Hispanic American adults are less consistent compared to African Americans and research on Asians in this area is limited (Acevedo-Garcia, 2001; Acevedo-Garcia et al., 2003; Eschbach et al., 2004; Gee, 2002; Kramer & Hogue, 2009; Lee & Ferraro, 2007; Patel et al., 2003; Reyes-Ortiz et al., 2009; Walton, 2012). To our knowledge, none have focused on SSB consumption, one of the important drivers of the obesity epidemic in the U.S. Existing literature suggests that neighborhoods with higher density of ethnic minorities (e.g. Hispanics and African Americans) are more likely to be poor and economically disadvantaged (D. Massey & Denton, 1988; D. S. Massey, Rothwell, & Domina, 2009; Quillian, 2012), but the effects of ethnically mixed neighborhoods on dietary behavior have not been well studied. In this study, we attempted to disentangle individual and neighborhood level factors and focused on how neighborhoods with different ethnic densities are associated with SSB consumption patterns.

The lack of studies examining the entire ethnic distribution of neighborhoods is well-recognized (White & Borrell, 2011). A limited number of studies assess the association between health and neighborhood composition, especially in “majority-minority” neighborhoods in which minority groups constitute the majority of residents (Osypuk et al., 2009; Osypuk & Acevedo-Garcia, 2010; Walton, 2009). To our knowledge, none assessed SSB consumption. The variable for racial neighborhood concentration of <50% non-Hispanic White was created to capture and examine the associations of SSB consumption and multiethnic, majority-minority neighborhoods that otherwise would not have been captured under the  $\geq 25\%$  Hispanic or  $\geq 25\%$  Asian neighborhood categories. The associations of SSB consumptions were weaker in these neighborhoods compared to neighborhoods in which  $\geq 25\%$  were Hispanic and only non-Hispanic Whites and Hispanics demonstrated an increased odds of SSB consumption in the past seven days. However, given the scarce research in regards to multiethnic neighborhoods and health, the findings of this study contribute to the limited literature in this area.

We also demonstrated that a typical with  $\geq 25\%$  Hispanics (where the majority of Hispanics in California reside) were independently associated with increased soda consumption, regardless of the individual’s race, after relevant individual and neighborhood environment factors were adjusted.

This study demonstrated that individuals residing in a typical California neighborhood where the density of Hispanic is  $\geq 25\%$  compared to neighborhoods is with <25% Hispanic that are mostly composed of higher percentages of non-Hispanic White and Asian, is associated with an increased odds of soda consumption. Reyes-Ortiz et al

found that higher percentages of Mexican-Americans at the census tract level were associated with higher consumption of traditional Mexican food, suggesting consumption of a healthier diet (Reyes-Ortiz et al., 2009). However, unhealthy dietary practices, such as SSB and fast-food consumptions, were not assessed in their study and the sample population did not include non-Mexican Americans to compare dietary patterns across difference races/ethnicities. In this study, it was demonstrated that in addition to Hispanics, non-Hispanic Whites, African Americans, and Asians were also all at increased odds of any soda consumption in these neighborhoods. It is possible that specific community characteristics or contextual explanations of neighborhood quality unique to these more racially mixed neighborhoods contributed to this adverse association of increased soda consumption. Nonetheless, this finding provides important public health and policy implications in terms of public health programs aiming to reduce soda consumption in these typical California neighborhoods where more than 57% of the total California population and an overwhelming percentage of ethnic minorities (44.9% Asian, 84.5% Hispanic, and 69.1% African American) reside. Future research should examine other neighborhood contextual and environmental factors not assessed in this study, such as social cohesion, civic participation, and accessibility to healthcare providers in these racially mixed neighborhoods, which may elucidate further insights into this negative relationship. Qualitative research can also play an important role in exploring factors affecting these racially mixed neighborhood quality that otherwise can be difficult to capture in quantitative studies.

Furthermore, given the high percentage of foreign-born Hispanics from Mexico living in California (and in this study population in which over 80% of Hispanic foreign



born were from Mexico), future research is needed to assess whether the consumption patterns of SSB in neighborhoods with higher percentages of Hispanic Mexicans differ from neighborhoods with higher percentages of Hispanics of non-Mexican origin.

Beverage industry data demonstrate that Mexico is the second largest consumer of soda in the world (ANAPRAC 2005) and the latest national health data from 2012 suggest an increase in secular trend of SSB consumption in the country among both adults and adolescents (Barquera, S. 2008; 350 Stern, D. 2014). Assessing the associations of factors such as differences in length of residence or the percentages of immigrants vs. U.S. born adults among Mexican and Hispanics of non-Mexican origin could further ascertain SSB consumption patterns in various California neighborhoods.

Existing evidence suggests that neighborhoods with higher percentages of Asian have greater levels of material and social resources (J. Logan, 2011), more positive occupational environments and greater social mobility (Zhou & Kim, 2006) compared to their Hispanic and African American ethnic neighborhoods in the U.S. (J. Logan, 2011; Walton, 2012). This, in turn, may lead to positive effects on health based on more favorable social environments in these neighborhoods. A few studies have indeed demonstrated that primarily Asian neighborhoods is positively associated with positive health effects, including higher birth weight (Walton, 2009), lower BMI (Kirby et al., 2012), and lower consumption of high-fat foods and better health food availability (Osypuk et al., 2009).

Although our study found that neighborhoods with higher percentages of Asian have higher median income, the associations with SSB consumption in these neighborhoods were equivocal. Hispanics living in these neighborhoods were found to

have lower odds of soda consumption, but this was countered by increased odds of consumption of flavored/sports drinks in this population. Furthermore, in the Asian sub-analysis, Koreans had significantly higher odds of SSB consumption when living in Asian neighborhoods. Of the existing literature on Asian neighborhoods and health, one recent study assessing the impact of Asian enclaves on cervical cancer incidence did demonstrate a negative relationship, and is further contributing to the debate in this area (Froment, Gomez, Roux, Derouen, & Kidd, 2014). Research on the health effects of neighborhoods with high percentages of Asian needs to be further explored, as existing evidence is inconsistent.

## **LIMITATIONS**

There are some limitations of this study. Although census tracts are, by design, relatively homogenous units with respect to socioeconomic characteristics, smaller geographic units (e.g. census blocks) can provide finer geographic delineation when defining geographical neighborhoods. Others have used the concept of spatial clustering that is composed of continuous geographic areas to better identify ethnic communities (J. R. Logan, Alba, & Zhang, 2002; Walton, 2012). Second, neighborhoods with higher density of African Americans compared to typical California neighborhoods were not assessed, as the percentages of these neighborhoods were too small to include in the analysis given the relatively low percent of African Americans compared to other ethnic minorities living in California. Third, while the overall sample size in this study was large, the smaller sample sizes among the Asian subgroups have limited statistical power when assessing the differential associations of SSB consumption by Asian subgroups. Furthermore, the disaggregation of the types of SSB (e.g. soda, coffee, flavored/sports

drinks) was not included in the Asian subgroup analysis, as the frequencies of soda and flavored/sports drink consumption among these groups were too low to generate stable estimates. Fourth, dietary and beverage questions in the CHIS did not include serving size and therefore, the study only ascertained the frequency of consumption. Lastly, although more than one-third of Asian Americans and more than a quarter of Hispanics in the U.S. live in California (Humes, Jones, & Ramirez, 2011), the results from this study may not be generalizable across the country given the unique neighborhood demographics in California compared to other states in the U.S.

## **CONCLUSION**

This study demonstrates that ethnic neighborhoods, with various ethnic densities are associated with different SSB consumption patterns. Ethnically diverse neighborhoods, including those with  $\geq 25\%$  Hispanics, are associated with the increased odds of SSB consumption. These findings suggest that additional research is needed to explore why these neighborhoods are associated with increased soda consumption, even among non-Hispanic residents living in such communities. Understanding the underlying factors can enable policymakers to better define and target prevention efforts toward SSB consumption in various neighborhoods in California. In the absence of consistent findings, researchers should further explore the relationship between Asian ethnic neighborhoods and health behaviors/outcomes. These findings suggest that additional research is needed to further explore the underlying factors on how neighborhood ethnic densities affect individual's SSB consumption. Evidence suggests that the incorporation of neighborhood factors can attenuate health disparities (Do et al., 2008). The findings of this study can help generate further interest among researchers and policymakers in

delineating the complex interplay of individual, social, environmental and cultural factors to ameliorate broader health disparities in the United States.

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**Table 5.1 Ethnic Minority Composition by Ethnic Density in California, 2010 Census Data**

Ethnic Density in 2010 Census Tract	Number (%) of Census Tracts*	Percent of Total Population in California in tracts	Ethnic Minority Composition within Census Tracts by Neighborhood Ethnic Density		
			% Asian Population in tracts	% Hispanic population in tracts	% African American population in tracts
Total in California (N)	8,057	37,253,956	4,861,007 (13.0%)	14,013,719 (37.6%)	2,299,072 (6.6%)
Non-Hispanic White					
≤35%	3,754 (46.8%)	49.1%	16.0% <sup>†</sup>	56.0%	9.2%
>35-50%	1,150 (14.3%)	14.8%	15.2%	30.0%	5.5%
>50-65%	1,242 (15.5%)	15.4%	11.4%	21.3%	3.4%
>65%	1,878 (23.4%)	20.7%	5.9%	11.8%	1.6%
Hispanic					
≤25%	3,603 (44.9%)	42.3%	17.0%	13.8%	4.5%
>25-35%	987 (12.3%)	12.9%	15.9%	29.7%	7.2%
>35-50%	1,087 (13.5%)	14.3%	12.5%	42.2%	9.4%
>50%	2,347 (29.2%)	30.6%	6.6%	71.7%	6.5%
Asian					
≤10%	4,814 (60.0%)	58.9%	4.2%	43.5%	6.4%
>10 -24.9%	2,031 (25.3%)	25.5%	15.6%	33.5%	6.6%
≥25%	1,179 (14.7%)	15.6%	42.4%	22.4%	4.8%
African American					
≤5%	5,411 (67.4%)	66.5%	13.2%	35.4%	2.0%
>5-10%	1,213 (15.1%)	16.0%	14.0%	40.7%	7.0%
>10%	1,400 (17.4%)	17.5%	11.4%	43.0%	21.3%

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\*Thirty three (33) of the 8,057 Census Tracts in California were uninhabited 2010

† Among the census tracts that are  $\leq 35\%$  Non-Hispanic White in California, 16% of the total population residing in these census tracts are Asians



**Table 5.2: Total Distribution of Ethnic Minorities living in California by Ethnic Density and Neighborhood Characteristics, 2010 Census**

Ethnic Density in 2010 Census Tract	Number (%) of Census Tracts*	Percent of Total Population in California	Distribution of Ethnic Minorities by Ethnic Density			Median Income per capita in the last 12 months(US\$)	% Foreign Born
			% Asian Distribution	% Hispanic Distribution	% African American Distribution		
Total in California (N)	8,057	37,253,956	4,861,007 (13.0%)	14,013,719 (37.6%)	2,299,072 (6.6%)	30,935 (14,010)	26.7%
Non-Hispanic White							
≤35%	3,754 (46.8%)	49.1%	60.0% <sup>‡</sup>	73.0%	73.0%	23,610 (9,453)	36.1%
35-50%	1,150 (14.3%)	14.8%	17.1%	11.8%	13.1%	32,291 (11,056)	23.2%
50.1-65%	1,242 (15.5%)	15.4%	13.5%	8.8%	8.5%	36,772 (13,175)	19.0%
>65%	1,878 (23.4%)	20.7%	9.3%	6.5%	5.3%	40,913 (15,498)	12.9%
Hispanic							
≤25%	3,603 (44.9%)	42.3%	55.1%	15.5%	30.9%	39,773 (14,995)	20.4%
25-35%	987 (12.3%)	12.9%	15.7%	10.2%	15.0%	29,926 (8,417)	24.2%
35.01-50%	1,087 (13.5%)	14.3%	13.6%	16.0%	21.7%	25,937 (7,121)	26.0%
>50%	2,347 (29.2%)	30.6%	15.6%	58.3%	32.4%	20,160 (5,007)	36.9%
Asian							
≤10%	4,814 (60.0%)	58.9%	18.8%	68.0%	60.6%	28,286 (12,428)	22.7%
10.01-25%	2,031 (25.3%)	25.5%	30.5%	22.7%	27.2%	34,676 (15,166)	27.7%
≥25%	1,179 (14.7%)	15.6%	50.7%	9.3%	12.2%	35,298 (15,409)	40.2%
African American							
≤5%	5,411 (67.4%)	66.5%	67.5%	62.7%	21.6%	35,298 (15,409)	26.6%
5-10%	1,213 (15.1%)	16.0%	17.1%	17.3%	18.0%	28,477 (10,783)	27.2%
>10%	1,400 (17.4%)	17.5%	15.3%	20.0%	60.4%	24,328 (9,965)	26.8%

\*Thirty three (33) of the 8,057 Census Tracts in California were uninhabited in 2010 <sup>‡</sup> Sixty percent (60.0%) of all Asians residing in California reside in census tracts that have an ethnic density of <35% Non-Hispanic White

**Table 5.3 Ethnic minority composition by ethnic density in the 2009 California Health Interview Survey (Adult Component)**

Ethnic Density in 2010 Census Tract	Number (%) of Census Tracts by Ethnic Density*	Proportion of weighted population	Ethnic minority composition by Neighborhood Ethnic Density		
			Weighted % Asian Population (2009 CHIS)	Weighted % Hispanic population (2009 CHIS)	Weighted % African American population (2009 CHIS)
Total in California (N)	8,057	45,966	4,761 (12.9%)	8,222 (32.2%)	1,848 (5.7%)
Non-Hispanic White					
≤35%	3,754 (46.8%)	45.7%	15.6% <sup>†</sup>	50.6%	9.4%
>35-50%	1,150 (14.3%)	15.0%	15.9%	25.1%	4.1%
>50-65%	1,242 (15.5%)	16.2%	11.6%	18.8%	2.4%
>65%	1,878 (23.4%)	23.1%	6.4%	9.9%	1.7%
Hispanic					
≤25%	3,603 (44.9%)	46.2%	16.3%	12.7%	4.0%
>25-35%	987 (12.3%)	12.7%	15.3%	26.9%	4.6%
>35-50%	1,087 (13.5%)	13.9%	11.8%	36.3%	9.1%
>50%	2,347 (29.2%)	27.2%	6.4%	66.0%	7.4%
Asian					
<10%	4,814 (60.0%)	58.3%	4.5%	36.2%	5.7%
>10-24.9%	2,031 (25.3%)	25.3%	16.1%	30.3%	6.0%
≥25%	1,179 (14.7%)	16.4%	37.5%	21.1%	5.1%
African American					
≤5%	5,411 (67.4%)	69.0%	12.7%	30.3%	1.9%
>5-10%	1,213 (15.1%)	14.6%	13.8%	36.7%	7.0%
>10%	1,400 (17.4%)	16.4%	12.7%	36.3%	20.1%

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\*Thirty three (33) of the 8,057 Census Tracts in California were uninhabited in 2010

† Among the census tracts that are  $\leq 35\%$  Non-Hispanic White in California, 15.6% of the total population residing in these census tracts in the sampled population in the 2009 California Health Interview Survey (Adult component) are Asians

**Table 5.4: Total Distribution of Ethnic Minorities living in California by Ethnic Density and Neighborhood Characteristics in 2009  
California Health Interview Survey (Adult component)**

Ethnic Density in 2010 Census Tract	Number (%) of Census Tracts by Ethnic Density	Distribution of Ethnic Minorities by Ethnic Density				% living below poverty in the last 12 months	% with Bachelor's degree or higher	% Foreign Born (2009 CHIS)
		Total weighted population	Weighted % Asian Distribution	Weighted % Hispanic Distribution	Weighted % African American Distribution			
Total in California (N)	8,057†	45,966	4,761 (12.9%)	8,222 (32.2%)	1,828 (5.7%)	15.8% (15.1-16.6%) <sup>δ</sup>	34.0% (33.2-33.7%)	33.0% (32.2-33.7%)
<b>Non-Hispanic White</b>								
≤35%	3,754 (46.8%)	45.7%	55.4%‡	71.8%	75.3%	18.0% ** (17.7-18.4%)	22.1% ** (21.0-23.3%)	37.1% ** (36.7-37.5%)
>35-50%	1,150 (14.3%)	15.0%	18.6%	11.7%	10.9%	11.8% (11.2-12.3%)	39.0% (36.8-41.3%)	24.4% (23.9-24.9%)
>50-65%	1,242 (15.5%)	16.2%	14.6%	9.4%	6.9%	9.3% (9.0-9.6%)	40.7% (38.7-42.7%)	18.9% (18.4-19.3%)
>65%	1,878 (23.4%)	23.1%	11.5%	7.0%	6.9%	7.7% (7.5-7.8)	49.4% (47.7-51.0%)	13.0% (12.5-13.4%)
<b>Hispanic</b>								
≤25%	3,603 (44.9%)	46.2%	58.5%	18.2%	32.3%	8.7% ** (8.5-9.0%)	48.9% ** (47.6-50.3%)	20.7% ** (20.3-21.1%)
>25-35%	987 (12.3%)	12.7%	15.1%	10.6%	10.2%	11.7% (11.4-12.1%)	33.8% (31.2-36.0%)	24.2% (23.3-25.0%)
>35-50%	1,087 (13.5%)	13.9%	12.8%	15.6%	22.3%	14.6% (14.0-15.1%)	24.6% (22.0-26.5%)	27.0% (26.1-27.8%)
>50%	2,347 (29.2%)	27.2%	13.6%	55.6%	35.3%	21.1% (20.6-21.6%)	13.5% (12.1-14.8%)	38.0% (37.4-38.4%)
<b>Asian</b>								
≤10%	4,814 (60.0%)	58.3%	20.6%	65.5%	58.6%	14.7% * (14.4-14.9%)	27.6% ** (26.6-28.5%)	22.1% ** (21.7-22.4%)
>10-24.9%	2,031	25.3%	31.6%	23.8%	26.8%	11.7%	40.0%	28.3%

	(25.3%)					(11.3-12.1%)	(37.9-42.0%)	(27.7-28.8%)
≥25%	1,179 (14.7%)	16.4%	47.8%	10.7%	14.6%	10.9% (10.2-11.6%)	47.5% (44.7-50.2%)	40.7% (40.0-41.3%)
<b>African American</b>								
	5,411 (67.4%)					11.5% ** (11.3-11.7%)	37.1% ** (36.2-38.0%)	26.2% * (25.8-26.5%)
≤5%		69.0%	68.2%	65.0%	23.9%			
	1,213 (15.1%)					14.4% (13.9-14.9%)	30.0% (27.4-32.4%)	27.6% (26.8-28.3%)
>5-10%		14.6%	15.6%	16.6%	18.0%			
	1,400 (17.4%)					19.7% (19.1-20.2%)	24.4% (22.3-26.5%)	28.0% (27.2-28.8%)
>10%		16.4%	16.2%	18.4%	58.1%			

†Thirty three (33) of the 8,057 Census Tracts in California were uninhabited in 2010

‡ Fifty five percent (55.4%) of all Asians residing in California of the weighted 2009 CHIS sample reside in neighborhoods that have an ethnic density of ≤35% Non-Hispanic White

δ Proportion (95% confidence intervals); \* p-value <0.05; \*\* p-value <0.01

**Table 5.5 Sugar-sweetened beverage (SSB) consumption occasion per week by ethnic density neighborhoods in California, 2009 California Health Interview Survey Adult component**

Ethnic Density in 2010 Census Tract	Number (%) of Census Tracts <sup>†</sup>	Total Sample in 2009 (weighted)		Total SSB consumption frequency occasion per week		Total soda consumption frequency per week		Total Coffee consumption frequency per week		Total Fruit/Sports drinks consumption frequency per week	
Total in California	8,057	45,966		7.5 (7.2-7.8) <sup>‡</sup>		2.1 (2.0-2.3)		3.1 (3.0-3.2)		2.2 (2.1-2.4)	
Non-Hispanic White											
≤35%	3,754 (46.8%)	45.7%	**	8.9 (8.4-9.4) **		2.7 (2.4-3.0) **		3.3 (3.1-3.5) **		2.9 (2.6-3.1) **	
>35-50%	1,150 (14.3%)	15.0%		7.3 (6.8-7.7)		2.0 (1.8-2.3)		3.1 (2.8-3.5)		2.1 (1.8-2.3)	
>50-65%	1,242 (15.5%)	16.2%		6.4 (6.0-6.7)		1.6 (1.4-1.8)		3.1 (2.9-3.3)		1.6 (1.5-1.8)	
>65%	1,878 (23.4%)	23.1%		5.6 (5.3-5.9)		1.3 (1.2-1.4)		2.8 (2.7-3.0)		1.5 (1.4-1.6)	
Hispanic											
≤25%	3,603 (44.9%)	46.2%	**	5.9 (5.7-6.1) **		1.4 (1.3-1.5) **		2.9 (2.8-3.0) **		1.6 (1.5-1.7) **	
>25-35%	987 (12.3%)	12.7%		7.1 (6.7-7.5)		1.9 (1.7-2.1)		3.3 (3.0-3.6)		1.9 (1.7-2.1)	
>35-50%	1,087 (13.5%)	13.9%		9.6 (8.4-10.7)		3.1 (2.4-3.8)		3.5 (3.1-3.8)		3.0 (2.5-3.5)	
>50%	2,347 (29.2%)	27.2%		9.3 (8.8-9.8)		2.9 (2.6-3.2)		3.3 (3.1-3.5)		3.1 (2.8-3.3)	
Asian											
≤10%	4,814 (60.0%)	58.3%	**	7.7 (7.5-8.0)		2.2 (2.1-2.4)		3.2 (3.0-3.3)		2.4 (2.2-2.5)	*
>10-24.9%	2,031 (25.3%)	25.3%		7.1 (6.8-7.5)		1.9 (1.7-2.1)		3.2 (2.9-3.4)		2.1 (1.9-2.2)	
≥25%	1,179 (14.7%)	16.4%		7.2 (6.2-8.2)		2.1 (1.5-2.7)		3.1 (2.8-3.3)		2.0 (1.6-2.4)	
African American											
≤5%	5,411 (67.4%)	69.0%	*	7.0 (6.7-7.3) **		1.9 (1.8-2.1) **		3.0 (2.9-3.2)		2.1 (1.9-2.2)	**
>5-10%	1,213 (15.1%)	14.6%		7.7 (7.2-8.2)		2.0 (1.9-2.2)		3.3 (3.0-3.7)		2.3 (2.1-2.6)	
>10%	1,400 (17.4%)	16.4%		9.2 (8.5-9.8)		2.9 (2.5-3.3)		3.4 (3.1-3.7)		2.9 (2.6-3.2)	

<sup>†</sup>Thirty three (33) of the 8,057 Census Tracts in California were uninhabited in 2010

<sup>‡</sup> Mean (95% confidence interval)

\* p-value <0.05; \*\* p-value <0.01

**Table 5.6. Individual and Neighborhood levels characteristics of adults ≥18 years old in the 2009 California Health Interview Survey, by race/ethnicity<sup>1</sup>**

	<i>White</i>	<i>Hispanic</i>	<i>Asian</i>	<i>African American</i>	
Total population (N=45,966)	31,085	8,222	4,811	1,848	
Unweighted %	67.6%	17.9%	10.5%	4.0%	
Weighted %	47.9%	33.1%	13.2%	5.8%	
<b><i>Individual variables</i></b>					
Total SSB <sup>2</sup> occasion in the past 7 days	6.4(.2)	9.4(.2)	6.0(.2)	8.4(.6)	**
Soda	1.8 (.1)	2.8(.1)	1.3(.1)	2.4(.2)	**
Coffee/tea	2.9(.1)	3.4(.1)	3.2(.1)	3.0(.2)	**
Flavored/sports drinks	1.6(.1)	3.3(.1)	1.6(.1)	3.0(.3)	**
Age (years)	49.0(.1)	39.9(.2)	43.3(.4)	46.2(.7)	**
Sex, Male (%)	49.0(.01)	50.6 (.01)	47.0 (.02)	45.6(.01)	**
Education (%)					
<12 years	4.5(.2)	37.3(.6)	8.9(1.1)	12.9(1.7)	**
High School Graduate/some College	51.8(.6)	49.7(.8)	35.6(1.5)	60.3(2.3)	
Bachelor's degree	27.2(.5)	9.2(.5))	36.0(1.6)	17.2(1.8)	
Master/PhD/ Professional degree	16.4(.4)	3.8(.3)	19.5(1.1)	9.5(1.3)	
Non-U.S. <sup>3</sup> born (%)	9.0(.4)	57.7(.9)	72.1(1.5)	10.5(1.7)	**
Age of arrival to U.S. among foreign born	29.2(.8)	21.2(.3)	20.4(.5)	18.4(2.9)	**
Poverty (%)					
0-99% FPL <sup>4</sup>	6.5(.5)	30.2 (1.0)	12.4(1.2)	20.3 (2.4)	**
100-199% FPL	11.1(.3)	27.4(.9)	17.5(1.3)	21.8(2.1)	
200-299% FPL	13.0(.4)	15.0(.7)	13.1(1.1)	14.9(1.6)	
300% FPL and above	69.4(.6)	27.3(1.0)	57.0(1.6)	42.8(2.5)	

**Community variables**

Neighborhood racial/ethnic concentration (%)

≥25 Black	1.5(.2)	4.1(.4)	2.7(.6)	22.3(1.9)	**
≥25 Hispanic	36.6(.6)	81.1(.8)	41.3(1.3)	67.8(2.2)	**
≥25 Asian	11.8(.4)	10.8(.7)	48.0(1.6)	14.7(1.7)	**
≥50 White	84.1 (.5)	50.1(1.2)	45.0(1.7)	32.3(2.4)	**
% Foreign born (tract)	20.3 (.1)	32.9 (.3)	34.1 (.5)	28.9 (.7)	**
% Residents in poverty (tract)	10.3(.1)	17.6(.2)	11.3(.3)	17.8(.6)	**
Grocery stores/1000	.21(.002)	.22(.002)	.22(.003)	.20(.004)	
Convenience stores/1000	.23(.001)	.22(.003)	.18(.003)	.19(.004)	**
Takeout restaurants/1000	.74(.007)	.68(.01)	.71(0.2)	.59(.01)	**

*1 mean or percentage ± standard error; 2 Sugar-sweetened beverages; 3 United States; 4 Federal poverty level*

*\*p<.05, \*\*p<.01 vs. non-Hispanic Whites*



**Table 5.7 Individual and Neighborhood levels characteristics of adults  $\geq 18$  years old in the 2009 California Health Interview Survey, by Asian subpopulations<sup>1</sup>**

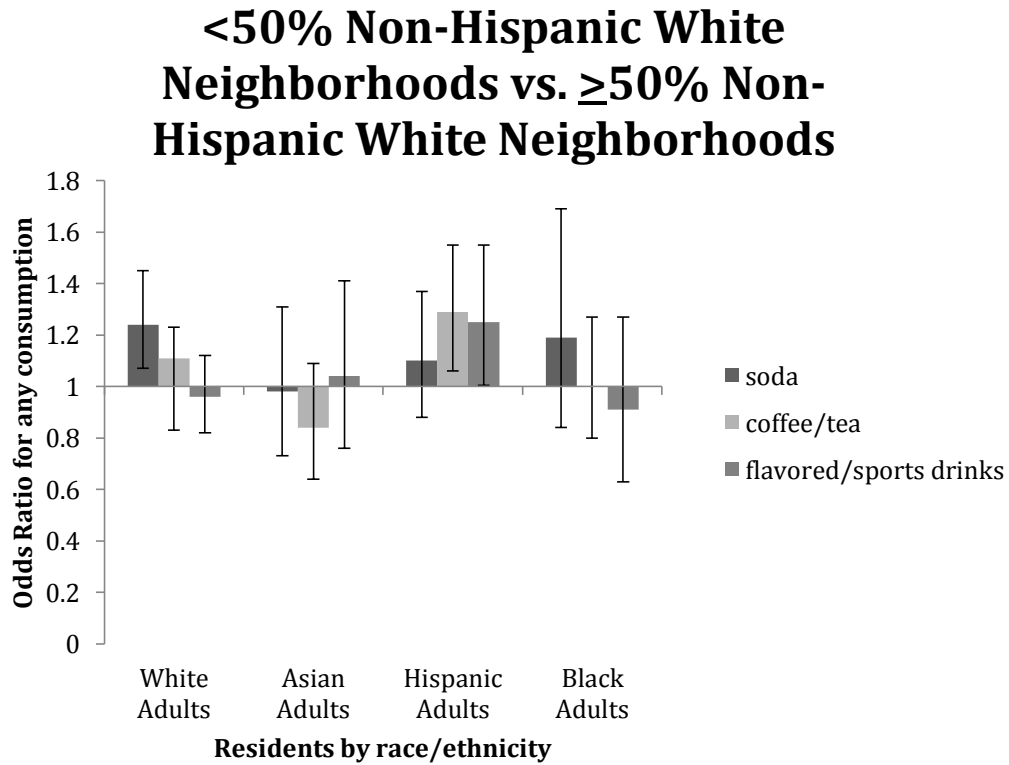
	<i>Chinese</i>	<i>Korean</i>	<i>Vietnamese</i>	<i>Filipino</i>	<i>Japanese</i>	<i>South Asian</i>	
Total population (N=4,761)	1055	950	1413	505	452	411	
unweighted %	22.2%	20.0%	29.7%	10.6%	9.5%	8.6%	
weighted %	29.1%	10.2%	12.1%	27.3%	7.4%	13.9%	
Total SSB <sup>2</sup> occasion in the past 7 days	4.3(.2)	5.9(.8)	6.4(.7)	6.4(.2)	6.1 (.9)	7.9(.6)	**
Soda	0.7(.1)	1.0(.2)	1.5(.3)	1.8 (.1)	1.4 (.4)	1.4(.3)	**
Coffee/tea	2.6(.2)	3.5(.6)	3.3(.7)	2.9(.1)	2.9 (.5)	4.7 (.4)	**
Flavored/Sports drinks	1.0(.1)	1.4(.2)	1.5(.3)	1.6(.1)	1.7 (.2)	1.8 (.3)	*
Age (years)	44.6(.8)	37.9(1.2)	41.6 (1.3)	49.0(1.0)	51.8 (1.5)	38.6 (1.0)	**
Sex, Male (%)	47.4(2.9)	29.5(5.0)	52.0 (5.1)	49.4(3.4)	41.0 (3.2)	59.4 (3.8)	**
Education (%)							**
<12 years	13.4(3.1)	5.6(1.1)	14.6 (3.3)	6.6 (2.5)	3.3 (1.5)	2.0 (.7)	
High School Graduate/some college	31.6(3.0)	33.6(4.8)	53.6 (5.8)	42.6 (3.4)	40.8 (3.9)	20.9 (3.2)	
Bachelor's degree	33.5(3.2)	46.8(5.4)	27.0 (4.0)	41.4(3.7)	33.9 (3.7)	27.7 (4.0)	
Master/PhD/ Professional degree	21.5(2.6)	14.0(2.7)	4.8 (1.3)	9.4(2.0)	22.0 (2.6)	49.4 (4.0)	
Non-U.S. <sup>3</sup> Born (%)	76.7(3.1)	62.8(6.0)	78.3 (6.1)	65.1 (3.4)	21.3 (2.7)	84.6 (4.2)	**
Age of arrival to U.S. among foreign born	20.6(.9)	17.8(1.3)	20.5(.9)	29.2(.8)	31.4 (2.1)	15.0 (.9)	**
Poverty (%)							**
0-99% FPL <sup>4</sup>	13.4(1.9)	14.5(3.6)	21.1 (3.1)	9.2(2.6)	6.1 (1.5)	5.1 (1.7)	
100-199% FPL	18.3(3.1)	15.7(3.8)	28.1 (4.8)	19.8(2.5)	8.3 (1.9)	7.2 (1.6)	
200-299% FPL	10.0(1.4)	11.6(2.5)	19.0 (7.1)	15.4 (2.2)	14.4 (2.8)	9.0 (1.9)	
300% FPL and above	58.3(3.1)	58.2(5.0)	31.7 (5.0)	55.64 (3.4)	71.2 (3.2)	78.8 (2.8)	

	<i>Chinese</i>	<i>Korean</i>	<i>Vietnamese</i>	<i>Filipino</i>	<i>Japanese</i>	<i>South Asian</i>	
<b>Community variables</b>							
Neighborhood racial/ethnic concentration (%)							
≥25 Black	2.3 (.8)	0.8 (.3)	3.1 (1.3)	5.9 (2.0)	4.7 (2.3)	0.3 (.2)	**
≥25 Hispanic	25.5(2.7)	39.2(5.5)	54.6(5.4)	59.7(3.3)	30.7 (3.2)	26.0 (3.3)	**
≥25 Asian	57.9(2.8)	48.9(6.1)	56.3(6.1)	30.8(3.3)	31.5 (3.4)	51.9 (4.1)	**
≥50 White	42.1(3.1)	45.1(5.8)	26.1(5.0)	50.3 (3.5)	66.3 (3.6)	54.3 (4.2)	**
% Foreign born (tract)	36.4(1.1)	33.7(1.5)	38.1(1.2)	32.1(1.0)	26.5 (.9)	31.2 (.9)	**
% Resident in poverty (tract)	10.7(.5)	12.5(1.1)	12.9(.8)	12.2(.7)	9.7 (.7)	8.3(.5)	**
Grocery stores/1000	.25(.03)	.21(.02)	.21(.01)	.20(.007)	.20 (.008)	.19 (.01)	**
Convenience stores/1000	.16(.007)	.18(.01)	.19(.01)	.23(.001)	.20 (.007)	.18 (.009)	**
Takeout restaurants/1000	.70(0.3)	.75(.04)	.74(.02)	.74(.007)	.75(0.4)	.73 (.03)	**

**1** mean or percentage  $\pm$  standard error; **2** Sugar-sweetened beverages; **3**United States; **4** Federal poverty level

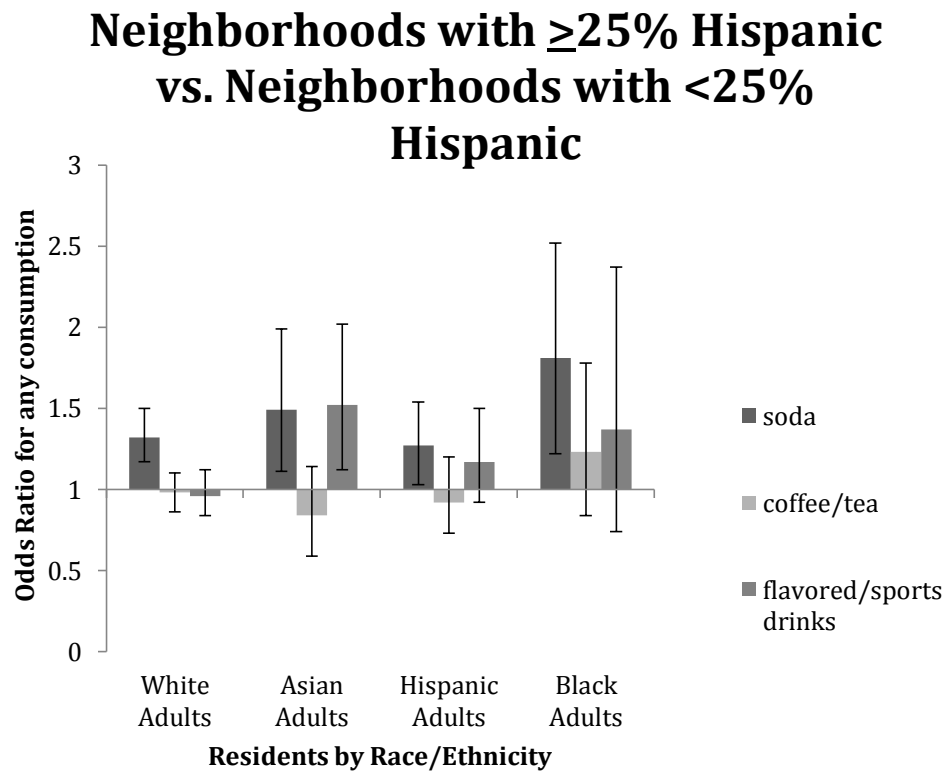
\* $p < .05$ , \*\* $p < .01$  vs. Chinese

**Figure 5.1: Adjusted odds ratios for any consumption over the past 7 days for individuals living in neighborhoods <50 % Non-Hispanic White compared to individuals who do not reside in neighborhoods <50% Non-Hispanic White, by beverage type and race/ethnicity\***



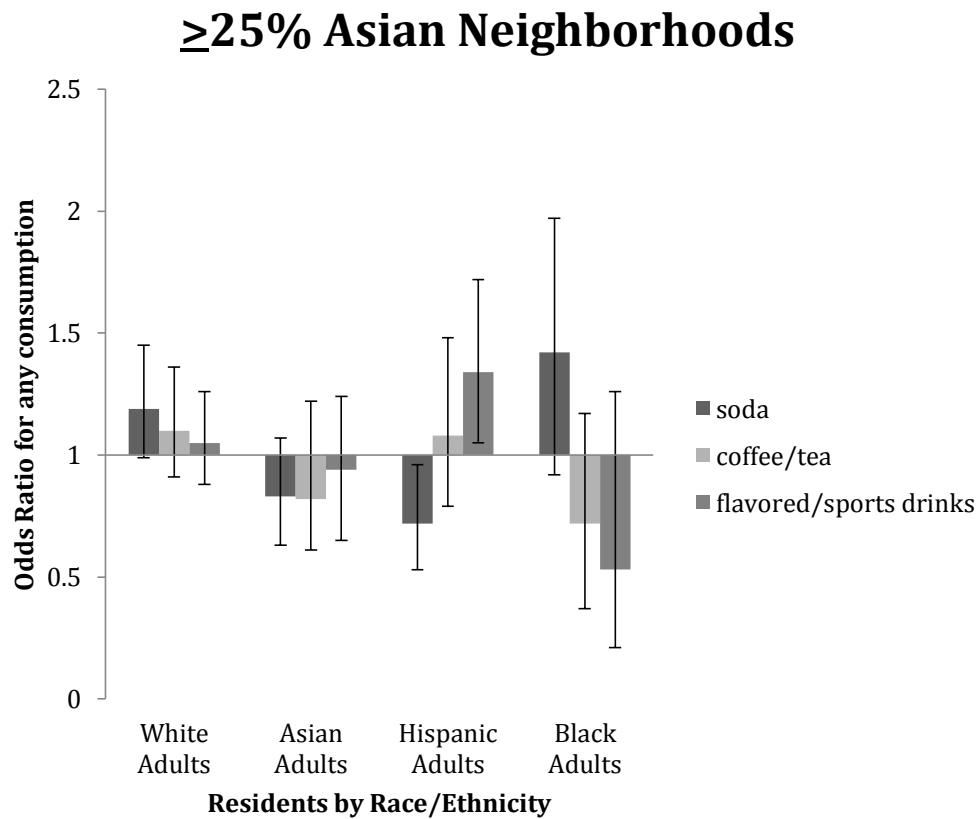
*\*Odds ratio estimates were adjusted for self-reported diabetes status and individual and neighborhood level factors listed in Table 5.6.*

**Figure 5.2 Adjusted odds ratios for any consumption over the past seven days for individuals living in neighborhoods  $\geq 25\%$  Hispanic compared to individuals who do not reside in neighborhoods  $\geq 25\%$  Hispanic, by beverage type and race/ethnicity\***



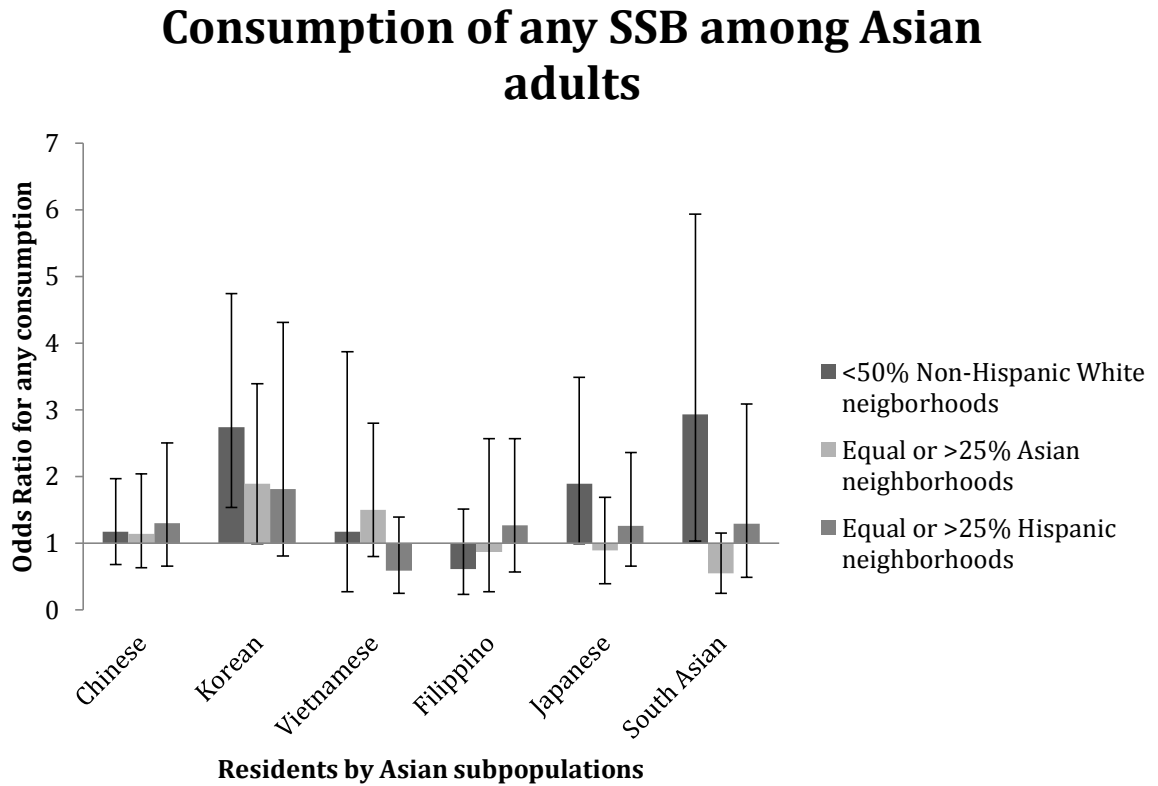
*\*Odds ratio estimates were adjusted for self-reported diabetes status and individual and neighborhood level factors listed in Table 5.6.*

**Figure 5.3 Adjusted odds ratios for any consumption over the past seven days for individuals living in neighborhoods  $\geq 25\%$  Asian compared to individuals who do not reside in neighborhoods  $\geq 25\%$  Asian, by beverage type and race/ethnicity\***



*\*Odds ratio estimates were adjusted for self-reported diabetes status and individual and neighborhood level factors listed in Table 5.6.*

**Figure 5.4 Adjusted odds ratios for any sugar-sweetened beverage consumption in the past 7 days among Asian subpopulations, by ethnic neighborhoods\***



*\*Odds ratio estimates were adjusted for self-reported diabetes status and individual and neighborhood level factors listed in Table 5.7.*

## CHAPTER 6: DISCUSSION, POLICY IMPLICATIONS, AND CONCLUSION

### *Sugar-sweetened beverage consumption and ethnic disparities*

Studies have documented the important role that sociodemographic determinants play in food choices and dietary intakes (Drewnowski, Darmon, & Briend, 2004; Forshee & Storey, 2006; Grimm, Foltz, Blanck, & Scanlon, 2012; Wilcox, Sharpe, Turner-McGrievy, Granner, & Baruth, 2013). To date, population-based data comparing SSB consumption among Asians have been limited. Our study included a large sample of Asians and subsequent sub-analyses of the Asian population, and demonstrated that race/ethnicity is an independent predictor of SSB consumption among U.S. adults living in California. Data from the 2009 CHIS adult component demonstrated that while the odds of any SSB consumption occasion per week among Asians were comparable to their non-Hispanic White counterparts (OR 1.2, 95% CI: 0.9-1.4), their SSB consumption frequency was significantly lower compared to Hispanics (OR 2.2, 95% CI: 1.9-2.6) and African Americans (OR 2.9, 95% CI: 2.3-3.6).

This study also found considerable differences in SSB consumption among the various Asian subgroups. The odds of consuming  $\geq 3$  SSB occasion per week were significantly higher among Filipinos (OR 1.9, 95% CI: 1.3-2.8), Vietnamese (OR 1.6, 95% CI: 1.0-2.4), and South Asians (OR 2.0, 95% CI: 1.3-2.9) when compared to their Chinese counterparts, who on average, consumed the least amount of SSB among all Asians. Poor diet intake and increased SSB consumption has often been associated with lower socioeconomic status (Drewnowski & Specter, 2004; Forshee & Storey, 2006), but this study found that despite the high level of educational attainment among South Asian

in this study (77% with a bachelor's degree or higher), they had a relatively high level of SSB consumption.

Previous studies have shown that the primary source of SSB consumption in the general U.S. adult population comes from soda and remains the largest source of added sugar in the diet (Bleich, Wang, Wang, & Gortmaker, 2009; Han & Powell, 2013; Welsh, Sharma, Grellinger, & Vos, 2011; Han & Powell, 2013). But results from this study suggest that the patterns of SSB consumption among Asians are vastly different from other ethnic minorities in the U.S. The odds of soda consumption occasions per week are significantly lower among Asians, while there is a high level of sugar-sweetened coffee/tea consumption across most Asian subgroups. The odds of individuals consuming  $>0$  and  $\geq 3$  soda occasions per week were significantly lower among Asians compared to other ethnic groups. However, the odds of Asian adults consuming any coffee/tea within the past week were significantly higher compared to non-Hispanic Whites (OR 1.4, 95% CI: 1.2-1.6). These results suggest that coffee/tea is the main driver of SSB consumption occasion among Asians, which differs significantly from the high soda consumption pattern in the non-Asian population in the U.S.

These findings have significant policy implications for future development of targeted policies for the rapidly growing Asian population in the U.S. To our knowledge, this is the first study that stratified the analysis of the Asian population on SSB consumption by their respective races. The results highlight the vastly different SSB consumption patterns within the Asian population, and researchers and policymakers should not design a “one size fits all” approach to obesity prevention programs or research studies for Asian Americans. Furthermore, our findings suggest that unlike the



rest of the U.S. (Huth, Fulgoni, Keast, Park, & Auestad, 2013; Kit, Fakhouri, Park, Nielsen, & Ogden, 2013; Welsh et al., 2011), soda is not the main driver of SSB consumption among Asians. Policies and nutrition programs targeting SSB to date has mostly targeted soda beverages (Elbel, Cantor, & Mijanovich, 2012), including two recent ballot initiatives on soda tax in California in 2012 (Gollust, Barry, & Niederdeppe, 2014; Jou, Niederdeppe, Barry, & Gollust, 2014). Given the different patterns of high coffee/tea and low soda consumption among Asians, these policy approaches may be less effective in reducing SSB consumption among Asians compared to other ethnic groups, and nutrition programs that target specifically on sweetened coffee/tea intake (and first determining where they are consuming these beverages, i.e. home vs. restaurant vs. café) should be considered as an alternative to the existing mainstream programs.

#### *Acculturation and SSB consumption among Asian Americans*

Three dimensions, namely, age of arrival in the U.S., language use/media preference and time exposure to U.S. were identified in this study and were then assessed on their differential associations with SSB consumption among Asians. The dimension of age of arrival resulted in the most number of significant findings in the association of acculturation and SSB consumption. Asian Americans who were born in the U.S. or had lived in the U.S. before the age of 18 would more frequently drink SSBs than those who arrived in the U.S. during their adulthood. In contrast, two acculturation dimensions, time exposure to the U.S. and language use/media preference, were not consistently associated with higher SSB consumption. The odds of consuming any SSB were 1.8 (95% CI: 1.2-2.7) times higher among all Asians born in the U.S. or have arrived in the U.S. before the age of 18 compared to those who arrived in the U.S. after age 18. These

higher odds of SSB consumption was significant for Chinese- and Japanese-origin Asians: OR=2.8 (95% CI: 1.3-6.0) and 2.4 (95% CI: 1.1-4.6), respectively. Similar to results found in a systematic review of the relationship between different acculturation measurements and diet among Latinos, the observed relationships in this study among Asians depended on the measure of acculturation (Ayala, Baquero, & Klinger, 2008). Among three acculturation constructs used in this study, it was clear that the age at immigration was the most sensitive measurement in delineating the relationship between acculturation and SSB consumption.

In the Asian subgroup analysis, increased acculturation was most strongly associated with the increased odds of soda intake among Chinese and Korean adults. This finding may imply that physical exposure to U.S. society at earlier stages of life plays an important role in selected Asian subgroups' overall beverage consumption pattern, and over time, this pattern becomes more consistent with the pattern seen in the general U.S. beverage consumption landscape where soda is the main driver of consumption (Bleich et al., 2009; Han & Powell, 2013; Welsh et al., 2011).

As the immigrant population becomes more diverse in this age of globalization, and with increasing evidence suggesting the differential influence of acculturation on dietary behavior among ethnic sub-populations (Ayala et al., 2008; Gomez, Kelsey, Glaser, Lee, & Sidney, 2004; Lara, Gamboa, Kahramanian, Morales, & Bautista, 2005), policymakers should consider greater specificity in the design and promotion of nutrition interventions and encourage cultural sensitivity in efforts to curtail the consumption of sugar-sweetened beverages among Asian Americans. They should be cognizant of the similarities across Asia subgroups and the dissimilarities that set them apart.

Furthermore, despite the growing number of measurements used in assessing acculturation, additional research is needed to validate appropriate measures of acculturation for specific Asian subgroups as their immigration and assimilation experiences can be vastly different.

#### *Neighborhood racial density and SSB consumption*

To our knowledge, this is the first study that demonstrated neighborhoods with various ethnic densities are association with different SSB consumption patterns in California. . Our findings suggest that living in a typical California neighborhood with  $\geq 25\%$  Hispanics is associated with increased soda consumption compared to those who do not live in these neighborhoods, regardless of race/ethnicity. Unfortunately, in the absence of additional literature examining this issue, researchers should further explore the relationship among ethnically diverse and “majority-minority” neighborhoods in regards to SSB consumption, as well as other health behaviors/outcomes in the future.

Findings in ethnic Asian neighborhoods were equivocal in which the only significant results were among Hispanics residents who had decreased odds of soda consumption, but they also had increased odds of flavored/sports drinks compared to their Hispanic counterparts. (White: OR 1.3, 95% CI: 1.2-1.5,  $p < 0.01$ ; Hispanic: OR 1.3, 95% CI: 1.0-1.6,  $p < 0.05$ ; Asian: OR 1.5, 95% CI: 1.1-2.0,  $p < 0.01$ ; African American OR 1.8, 95% CI: 1.2-2.7,  $p < 0.01$ ). A few studies have indeed demonstrated that Asian ethnic neighborhoods is positively associated with positive health effects, including higher birth weight (Walton, 2009), lower BMI (Kirby, Liang, Chen, & Wang, 2012), and lower consumption of high-fat foods and better health food availability (Osypuk, Diez Roux,

Hadley, & Kandula, 2009). However, our results did not support these earlier findings, although one recent study did find a negative relationship between Asian neighborhoods and cervical cancer (Froment, Gomez, Roux, Derouen, & Kidd, 2014). Research on the health effects of Asian ethnic neighborhoods need to be further explored as existing evidence is inconsistent.

## **CONCLUSION**

Findings from this dissertation suggest that race/ethnicity, acculturation, and neighborhood context are important factors associated with the differences in the frequency of SSB consumption among adults living in California. Furthermore, these differences extend to the Asian subpopulations. The oversampling of Asian Americans in the 2010 NHANES is a first step in the right direction by incorporating “Asians” as a separate race. It enables researchers and public health practitioners to address racial/ethnic influence that includes Asians on beverage consumption and dietary behavior in a nationally representative sample. But researchers should be cognizant of the underlying differences within the aggregated “Asian” race. Large prospective epidemiological studies that take the various Asian subpopulations into consideration, along with the different phases of acculturation, can provide opportunities to elucidate dietary changes and overweight/obesity risks over time in this rapidly changing population. Studies of this nature will enable researchers and policy makers to better define risk groups and optimize obesity-related prevention interventions for Asian Americans in the future.

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| 08/2014 | <b>Johns Hopkins Bloomberg School of Public Health,</b><br>Baltimore, MD<br>Doctor of Public Health (Dr.P.H.)<br>Department of International Health |
| 2005    | <b>Johns Hopkins Bloomberg School of Public Health,</b><br>Baltimore, MD Master of Public Health (M.P.H.)   |
| 2001    | <b>Yale University School of Medicine,</b> New Haven, CT<br>Master of Medical Sciences (M.M.S.)   |
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## PROFESSIONAL EXPERIENCES

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| 2011 – present | <b>United States Agency for International Development,</b> Washington, DC<br><i>Senior Monitoring and Evaluation Advisor, Office of HIV/AIDS</i><br>-Serve as the technical lead in HIV monitoring and evaluation for the Asia and Near East region and concentrated epidemics<br>-Design, evaluate, and guide strategic information investments in partner organizations in the Asia and Near East region to improve overall program sustainability, capacity building, and the delivery of quality services across PEPFAR technical areas<br>-Provide technical guidance in the monitoring and evaluation of HIV community-based interventions and community systems strengthening activities, and represented USAID in related international and multilateral meetings/events |
| 2009 –2011     | <b>United States Agency for International Development,</b> Washington, DC<br><i>Monitoring and Evaluation Advisor, Office of HIV/AIDS</i><br>-Served as the strategic information advisor to PEPFAR supported countries in Southern Africa and Asia. Activities included data quality assessment, development of indicator guidelines, and verification and harmonization of data generated by implementing partners<br>-Provided technical guidance and strategic direction in the development of long term monitoring and evaluation strategy and vision for PEPFAR programs in Southern Africa and Asia<br>-Provided technical guidance in the development and harmonization of community-level indicators for HIV programs   |

- Designed and conducted performance evaluation for USAID-funded programs in Asia
- 2008-2009      **World Bank**, Washington, DC  
*Consultant*, Global HIV/AIDS Program
- Reviewed and synthesized current published and grey literature assessing the impact of international HIV funding on health systems, specifically the delivery of health services in recipient countries
  - Developed conceptual frameworks for the evaluation of health services delivery related to the impact of internationally-funded HIV programs
  - Co-authored a chapter on the impact of international HIV funding in health services delivery in developing countries
- 2006-2007      **Johns Hopkins Medical Institution/ Guangxi Center for Disease Control**, Nanning, China  
*Senior Clinical Project Manager*, HIV Prevention Trials Network (HPTN)
- Managed infrastructure development and roll out of NIH-funded Phase III HPTN buprenorphine/naloxone HIV harm reduction clinical trial among people who inject drugs
  - Directed cross-functional teams and conducted technical training for project staff
  - Developed study protocol and standard operating procedures pertaining to quality assurance/quality control, data management and supply chain management
  - Designed and conducted community outreach activities in rural Guangxi on HIV/AIDS prevention and safe injection practices
- 2005-2006      **William J. Clinton Foundation/Chinese Center for Disease Control**, Beijing, China  
*International Project Manager*, Clinton HIV/AIDS Initiative (CHAI)
- Managed CHAI related programs in China including HIV treatment and prevention, monitoring and evaluation of the national HIV program, and procurement of antiretroviral therapy
  - Assisted in the management of the Chinese national treatment program in partnership with the national government, WHO, US CDC, UNAIDS and UNICEF
  - Provided technical guidance in the development of the national HIV treatment evaluation plan, HIV/TB Co-infection study, and PMTCT pilot projects
  - Analyzed national pediatric HIV treatment data and produced publications in peer-reviewed journals
- 2002-2004      **Maywood Medical Group**, Los Angeles, CA  
*Physician Assistant*, Family Practice/Internal Medicine
- Provided direct pediatric and adult outpatient care including clinical diagnosis, development and evaluation of treatment plans in the underserved Latino community
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## PUBLICATIONS

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